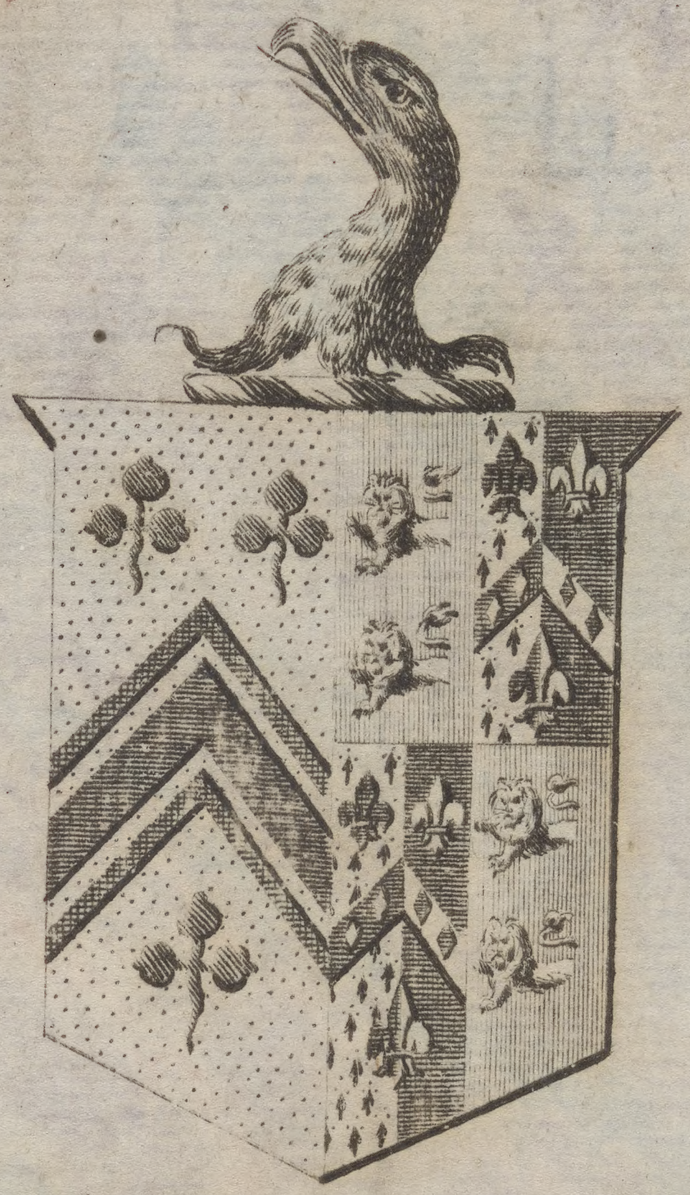

*J. R. Abdy Esqr.*

*Albyns.*

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# Naturall Philosophy

is that Science which gives the Reasons and Causes of those Effects and Changes which naturally happen in Bodies And that we may not be deceived by False Notions which we have embraced without examining; Or that we have read upon the Authority of Others. We ought to call in question all such things as have an appearance of Falsehood That by a new Examen we may be led to the Truth

This Examen is to be made by Suppositions which we may rely upon when they agree to Experiments But if only one Experiment is contrary

to any one Supposicon That Supposicon
must be rejected and a new one made
Till we find it agree with all other Exprim^ts
Therefore we must not go about to
Define a Cause, unless we know
its Effects or lay down a Generall
proposition If we doubt of any of the
particulars that it Comprehends. Least
we run into Error and take things for
granted Which have been found contrary
to Exprim^ts and Mathematicall
Demonstracons An Instance of this
may be given in what has formerly
been said about Heat & Cold Viz.
That Heat unites Homogeneous
Bodies and Seperates Heterogeneous
Bodies and that Cold unites Hete-
rogeneous Bodies All which we
find to be altogether False in several Instances

MSS. 833 B
RB NMAH



1st Mix & melt Gold & Silver together
& yᵉ Fire will not sopatt thom, Nother will it
sepate two parts of Brass mixt with one
of Copper

2d Ytt athor unites, thou soporates such hv=
terogeneous Bodys as hav an Aptness
to Coalition as in making plaistry
& Ointmᵗˢ &c And in uniting Salt petre
and Ashes into so durable a Body as Glass

Fire only dissociates the parts of Bodys
& Subdivides 'em into Minute ptticles with=
out respect to thoir being Homogeneous
Which is Evidᵗ in boyling Water or other
Liquors Whose Steams condense into the
same Substances again And in Distilla=tion
whon all the parts are in a Confusion upon
the Relaxing of the Heat or the parts
receding from it, When driven into the
Receiver thoy take place according
to thoir Specifick Gravity. Such parts
also as are most easily seporated are

carried over first As in the Distillacon
of Mans Blood, First Watre, Then
Spirits and Salt, Then Oil. The Earth
and Alkali remain togethr Because
of an equall degree of Fixedness The
Heterogenous Bodies but seperate
them as in the Urine of healthfull
people it causes a Sediment Which is again
dispersd & made to disappear by Heat
And by the Frost the strength of Wine
is seperated and unfrozen in the middle
of the Vessell

Straw, Dust, Wood &c are
no further united in Ice, then as they
are flettened up in the Frozen Watr
By Elem.ts the Philosphers
meant the most Simple Bodys
Of which they said all the Bodies that
we see are made and wch may be ex=
tracted from all Bodies But they have

been mistaken in Constituting their Elem^ts
Because they did not so much explain
the Nature of things; as what Sense
those things excite in us

They that considerd things
as affect the Sight, made only two
Elem^ts the Lucid & Opaque
Tho they gave but a blind Accompt
of Light & Colours

The four Elem^ts that have obtayn
so long only expriss'd the severall ways
that Touch is affected For those that
establisht 'em consider'd Heat and
Cold, Moisture & dryness. Sup=
=pos'd 'em the proprics and primary
Qualities of Bodies and accordingly
constituted 4 Elem^ts

The Earth
The Water
The Air
The Fire
} they suppos'd { Cold & dry / Cold & moist / Hot & moist / Hot & dry

To illustrate this Doctrine and

prove That thos are in & may be ex=
tracted from Bodies They used to burn
a piece of Green wood & call the Coals
& Flame Fire. Its Sweat Water.
The Smoke Air & the ashes Earth
But they can't be Elem^ts according to their
definitions For they are not Simple
& Unchangeable But may be altered
or produced de Novo

The Smoke which they called Air
may be condensed into a Liquor

The Fire is only Subtle Matter
in a Rapid motion The Moisture will
produce Caput mortuum & Oils. The
Ashes w^ch they call Earth will make
Glass.

Besides so[me] all things
are not reducible into 4 Nitrogenous
Bodies As, Gold, Silver, Diamonds —
Common Glass

V. motion

The they and
the Chimists have often endeavoured
it and if they could do it Yet they could
not prove their Elem^ts to be Unmixt

Because Expm^ts shew the Contrary

The Chymists prples are Salt
Sulphur & Mercury Which they call
the Elem^ts but as Erroneously, For these
cannot be had from Gold, Glass Diam^ds
or may be destroyed and pried
di Novo

M^r Boyle affirms y^t Quicksilver
has been turned into Water & Sulphur
altered and that y^e Mercuriall Sulphury
& Salts of the Chimists are not Similar
Bodies Wherefas to be Elem^ts each ought
not differ from those of the same name
More than drops of Water do from one
another Others add to these
three prples Capit mortuum & phlegm
That is Water & Earth But these five
are produceible Even from Water alone &
Art can off 2 Elem^ts compound a Body
as Durable as any in the world Viz^t
Glass made of Ashes that have only
Salt & Earth

The doctrine of Acids and

Alcali's is faulty as the Forgoing
For non of those Hypotheses can
au for Firmness & Fluidity, The
phenomena of the Loadstone, The
Formacon of a Fetus, Sounds, and
a thousand other things y^t fall under
the Notice of a philosopher

And as long as the Chimist or
any other philosoph^r endeavour
to explain things by a number of
mixt Ingredients in a State of
Rest they will be deficient Since
the greatest p^te of the Affeccons of Matt
and consiqtly the phænomena of
Nature seem to depend on the Mocon
& continuance of the Smallest p^tes of the
Bodies

That philosophy therefore y^t
the most reasonable is to teaches

1st

That the Matter of all Natrall
Bodies is y^t same Nature, a Substance
Extended, Divisible & Impenetrable

2

That since there could be no

Change in Matter if all its ptˢ were
ptᶜ Rally at Rest among yᵐˢᵉlves —
To distinguish thᵉ Gen.ˡ call Matter
of thᵉ Univers.ᵉ into a Variety of Trade
Bodies it must have more in
which must be wholly disputed How Matter
came by that Mocon by those who acknow=
ledge not an Author of thᵉ Universe Yᵗ
since a Man is not thᵉ worst Naturalist
for not being an Atheist We allow that
thᵉ Origin of Mocon in Matter as well
as of Matter itself is from God

3 That Locall Mocon is thᵉ chief
prplo among Second Causes & thᵉ chief
Agent of all that happens in Nature —
Birth, Figure, Rest, Leitration, Textu-
being thᵉ effects of Mocon as in a Watch
or Key, it is Mocon yᵗ makes all ye fall
We suppose Matter at first pulled into
small pices of wᶜʰ shape any one pleases

to imagine and will say Cubicks as
the most Obvious

Then every one of those parts
being turned swiftly round its own Cent &
and also abt another Centre comon to
all the pts The Cubes must be worn
off of & of all of those parts & a fine
Dust be made by that Attrition
The small Dust is the Materia
Subtilis or first Elem.t The Cubes
that have been rubd round into Globuli
make the 2 Elem.t of not so swift
Motion as the first Which is agitated
betwixt y.e Interstices of the Globuli.

The Cubes that have not lost
their Shape by having their Angles much
broken make the third & most Active
Elem.t

To illustrate this Hypothesy,
Take Cubes of Clay, and shake them
together in a round Box till some of y.e
Angles are become pretty near round The
Dust or Grains y.e Materia Subtilis
The roundish pieces the Globuli of y.e

Second Elem.ts & such as have not much change their Shape ye 3d Elem.t

Tho we cannot positively say That Matter was this divided yt since we find such Kinds of ptcls in Bodies we shall look upon it as probable Because all Expim.ts confirm & none contradict this Hypothesis

That Firmness & Fluidity Heat & Cold Odours, Savo, Colours & Sounds depend upon the Shape size & Mocon of the ptcs may appear from two Cold things producing heat as Oil of Tartar & doliginum poured on Oil of Vitriol will cause it to boyl & fume &c

A solid Body will loose its Smell & Firmness by the Infusion of one Liquor and recover both by the Infusion of another As Camphire will be dissolvd and lose its Scent by the Infusion of Oil of Vitriol But by pouring in Water the Smell & Solidity will be restored

Sal armoniac dissolvd

in Water makes a Mixture colder than
each $\frac{u}{}$ Singly

Water will be rarifyed by means
of an Eolipile as to become Lighter than
Air and if the hand be held near the
mouth of the Eolipile the water that
strikes on y^e hand will again be condens^d
& become as heavy as at first. Several
more Expim^ts prove this Hypothesis

VIII if Firmness Fluidity, Heat
and Cold Smells & Savo^rs depended only
upon a mixture of Ingredients as some
affirme. Then

1: Two Cold things would continue cold w^n mixt
2 A Liquor w^th wt Smell could not
give Scent to another Liquor
3 Two Fluids whon mixt would
continue Fluid

But the Contrary is shown by se-
veral Expim^ts The Extencon of
Matter & its Impenetrability are Self-
Evident And its Divisibility appears
from the divisibility of Gold For an Ounce
of Gold will guild a large piece of Silver

which being drawn into Wire will like=
wise then be all over guilded Tho' Wire
be made so small as to reach about
150 miles For an Acc^t of the Divisibi=
lity of Gold given in Square Lines in
Clarks Rohault pt 1 Cap 9°

A Candle seen by a whole Mul=
titude shews the Divisibility of Matt^E
to be Infinite Becaus Rays of light
must enter every Mans eyes Formed
those fine parts of the Fluids made
an Impression on the Retina of
the Eye the Candle could not be seen

# Mechanic Prples

The Quantity of Motion
which sometimes call'd Momentū
or sometimes simply Motion is that
Force or Energy by w^ch a Body
changes its place The Quty of Motion

may be increasd Either by keeping the same qtity of Matter & augmenting the Velocity or by keeping the same Velocity & increasing the qtity of Matter or by increasing both And therefore the absolute force by wch Bodies are moved is known by the multiplicacon of their Celerity into their Matter or weight

As for Example In the 2 Bodies A B Let A be 5 pounds & B 2 pounds Let the Velocity with wch A is moved be 6 degrees & let B have 4 degrees of Velocity Then the digt of mocon in A will be 30 and in B 8 digt of Momentum or Mocon

(A 5 6) (B 2 4) (A 12 4) (B 2 30)

Suppose A to have 12 pds and B two pds Let A have 4 dogd of Velocity & B 30 The qtity of mocon in A will be 48 and in B 60 From hence it follows That any Little Body may have its motion equall to ye mocon of any grtr Body Viz If the Velocity of the Little Body is so much grtr then ye Velocity of the great Body as ye qtity of matter in ye

is greater then the gnty of Matter in the
other (viz) When both Bodies have
their Velocity reciprocally pro-
= portionable to their weight their Mo-
= mentum or gntys of moc on wch Ble
equall As for Example Let A be
50 pds and B 2 pds. Let the Velocity of A
be 3 and of B 75 Now 50 has y^d same
pporcon to 2 as 75 has to 3 And therefore
the gnty of moc on in A wch is 3 times
50 or 150 is equ^ll to y^e Moc on in B
wch is twice 75 or 150

Of the Velocities of Bodys
are Equall, their Quantities of Moc on
will be as their Matter wch is comby^nd
in them And therefore since all Bodys
(abstracting from y^e Resistance of air)
descend equally as fast in Vacuo as
a pound of Lead But suppose the
Lead 1000 times heavyer then the
Feather The Momentum of the
Lead will be 1000 times grter. Gra-
= vity is y^e Cause of the Descent of

* to Make Scale

* it will dispose

both Therefore there is a 1000 times more Gravity required to make y^e Lead descend than the feather So that the Feather w^ch has 1000 times lose Matter than the Lead may descend with as grt Velocity as y^e Lead The Momentum of the Lead being 1000 times grter than it

And consequently since all Causes are proportionall to their Effects, the Gravity of Bodies w^ch is proportionall to y^e Matter in Bodies And therefore the qtity of matter in any Body may be estimated by its weight & Therefore if an Inch of Lead be 6 times heavyer than an Inch of Wood, there must be 6 times more Matter in the Inch of Lead than in the same Bulk of Wood & hence may be drawn a good Argum^t for a Vacuum For tho we grant y^e Existence of a Materia Subtilis yet still

th. Question will returns How that Matt comes to be so Fine but by having Void Spaces

We must also Suppose y pores of all Body's to go in a streight Line & Horizontall & they must alw's move in y same Streight Direcon Otherwise the Matria subtilis will be Reflected & so consqtly not fill up all the pores The whole Effect of Mecha= nic Enginos is to diminish y Velocity of y Wright to be raisd So y the qtity of the Mocon it will have may be no more than y qtity of mocon of th. power that raisd y wright

Suppose a Man can raise 1h by his strength wout an Engine only ton pounds wright w a determinate degree of Velocity, Tis not possible for him w any Engine to raise 100 lbs wright th. same Velocity yt by y application of an Engine a Man can raise 100 pounds with the w part of th. Velocity

Now all that the Engine
dos is to diminish the
Velocity of the Weight So
as to make it's Motion uo
pla 3 fig 1 ter than the motion of the
power raising it

As may be seen in the Vectis w^ch wo
suppose as a Mathematic & Rigid or in=
flexible Line only moving round the point
C which is calld the Fulcrum. A C & C B
are calld the two Brachia. In the Statera
the 2 Bracchia (the one be longer then y^e
other) are equally heavy & consisting BC
pla 3 fig 1 keeps in Aquilibrio. A C is divided
into ten lengths, each of which is equ^l
to C B. Let 2 be the weight w^ch is to be
found out by hanging any given weight
P upon the Brachium A & moving it up
& down till it makes an Aquilibrium,
You will find out y^e weight 2 For since
P in the distance 5 is Equiponderate
w^t 2 it follows that 2 is Quindupla of P
as hee demonstrated

Now suppose That if the Brachia
are equ^l & Mau could only raise ten pd

Then I say that if you alter the Brachia & make A C ten times longer then B C, he can by this Engine raise 100 pds Because B C is but the 10th part of A C the space B b will be but the tenth part of A a and consequently when B moves it will have but the tenth part of the Velocity of A But by suppression the force of A is so great as to raise by that Velocity a Body of ten pounds Therefore it will raise by the tenth pte of the Velocity a Body of 100 pds weight From whence it follows that y^e weight at A will weigh ten pieces at B For because A a is ten times greater then B b the Velocity of one pound at A will be 10 times greater then the Velocity of 10 pounds at B And therefore their quantity of Motion will be equall The Velocities being reciprocally proportionall to their weight Since then the 2 Bodies have equall Momenta or equall forces when moved Those forces being contrary or acting Contrary y^e one to y^e other will destroy one another & keep an Aquilibrium

A point in any Body so plaed that all Matter on evry side Gravitates equally is called the Centre of Gravity of that Body The Centre of Gravity is not always in the Centre of Magnitude As in the Statera Romana Where by not requir'd That ye short Brachium should have an equall qtity of Matter to what y^d long one has

The Centre of Mocon is that point round w^ch If a Body moves every point of it discribes Circles Whose Centres are in y^e Centre of Mocon. The Centre of Gravity of all Bodies descends as much as it can & if a Body be suspended by its Centre of gravity it will retain any given posicon For in that case the Centre of gravity can not descend. If the Centr. of Gravity be differ^t from y^e Centre of mocon and then if the Centre of Gravity be out of the perpendicl^r The Body will turn round till the sd Centre of Gravity be just under the Centre of Mocon For then it has descended as much as it can

pla 3
fig 2

L.t A B be a Beam whos. Cent
of Mocon at M is above the Centre of Gravity
C. If it were turnd out of the horizontall
posicon the Centre of Gravity must —
ascend. Suppos. to K and therefore if the
Body be left to its. Self will turn round
till the Centr. of Gravity comes againto
its former posicon

In a Ballance the AXIS and the
Centr. of Mocon is a little above the Cent.
of Gravity For if it were exactly in it, it
would retain any given posicon But by
being above it the Beam of the Ballance
when in Aquilibrio must settle its. Self in
an horizont.l posicon

The Centr. of mocon may be just
below the Centr. of Gravity but if you move
them ever so little out of an exact ppendicl.r
the Scales will not be in an Aquilibrium
But as soon as you Let the Ballance hang
freely the Centre of Gravity will get below
the Centre of mocon

# Mechanic[k] Powers

## Definitions

pla 3
fig 2

1 A weight is any Body to be raisd or movd

2 A power is that Force by w[ch] a Weight is raisd Whether it be a force w[ch] draws or pushes or strikes or a weight w[ch] Gra=vitates For a wright is a powr in reference to y[e] heavy Body w[ch] it may move

3 The absolute Gravity of a Body is its Endeavo[r] to descend in a free Medium

4 The Relative Gravity of a Body is its Endeavour to descend when it touchs something else besides the parts of the Medium & this is always less then the absolute

5 Equilibrium is when there is the same Quantity of Mocon in the powr as there is in the wright Because those Mocons being contrary the one destroys the other

6 The Centre of mocon, Fulcrum or Fixt point are all the same

7 The Line of Direccon of a powr or wright is that in wch it indeavours to move In a heavy Body the right Line

pla 1 fig 1 by wch it indeavours to defend In a powr the Right Line by wch a powr drawg or pushes a wright to resistyn it If C draws A ovr B, B C is the Line of direccon of the powr & A D that of the wright by wch it resists the Fraction

pla 1 fig 2 8 The applicacon of a powr to a Vectis or Leaver is the Angle wch the Line of Direccon of that powr makes with the Leaver As the Angle A B E in fig 2

9 The Distance of a powr or Wright is a Line drawn from the first point perpendicl to ye Line of Direccon as C F in fig 2

10 In all Regular & homogene= ous Bodies the Centr of Gravity is in the Centre of Magnitude

# Suppositions

1 We must suppose the Earth Flatt Because the greatest Engines are Erected

a point wthin compard wth the Surfaco of the Earth

2 When heavy Bodies fall freely they make Lines ꝓpendicl to ye Earth meeting in the Centre of the Earth & thos. we are to suppos parallell

3 The Engines are supposd We must suppos them perfect That by such a Supposicon we may better find out what they'l doo As That Bodies are perfectly Hard, Smooth & Homogeneous, Liner Streight with-out wright, Thicknes or Flex-ibility & Cords extreamly plyable

# Axioms

1 To raise a wright wth an Engine the Velocity of the power must be increasd and that of the wright Lessend

2 The Centre of Gravity always desends as low as it can

3 A Body can fall no lower then its Centre of Gravity desends

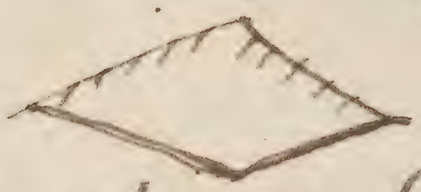
4 If all the wright of a Body was

reduced into its Centre of gravity it would move as before

## Problem

Prop: 1 How to make a heavy Body rise to raise of itself

The Body must be a Double Cone of wood or any solid matter As in this Fig



pla 1 fig 3

Set two long flatt peices of wood on a Table with one end upon two other cross peices as CCD so as to raise them almost as high above the horizontal plain (at the other end) as is the diffidence of the Radius at A & that at B Then lay the Body A B A upon them at D where they must meet in an Angle & it will rise up to C If the distance CC be no gter then the distance A A The reason follows

When the Body is layd on at D The Centre of Gravity which is in the middle of the Diamt B which is cut by the Axis A A (Because the Body is regular & homogenous

is higher than it is when the Body has rolled
to C Now because the Centre of Gravity
endeavours to fall as low as it can the
Body will roule to C where its Lowir
then it was before Tho its Supporters
be higher As will appear by Koleing a
Thread horizontally from D to E for
if the Body touch ye Throad when at
D it will be below it when it has rolled
to E

prop:

2 Theor: What is said of the Centre
of a heavy Body is to be understood
of its Centre of Gravity Because unles
the Centre of Gravity can fall, the Body
plat cant fall by the foregoing propositon
fig 5 For the Body A B C D which stands
upon the horizontal plain F C can't
fall tow^ds F. which it ineline Because
its Centre of Gravity E would rise Wch
appears by drawing the Arch E F about
the point B But A B C D (in fig 6) will
fig 6 fall Because its Centre of gravity can fall

as appears by Construccon

fig 4 Scholium. Since the first Impuls
of an heavy Body downw is begun at its
Centre of gravity & that the Centre of
Gravity endeavours to get as low as it
can An heavy Body must endeavour
to descend in a Line called the Line of
Direccon as EG or CO drawn from
its Centre of gravity to y^e Centre of the
Earth or Centrum Gravium Which
is y^e lowest place & if it can't move in
the Line EG by reason of y^e interposicon
of a plain so inclind as not to hinder
y^e Centre of gravity from descending
will fall obliquely by sliding or rouling
so as to get into the line of Direccon CO
as fast as it can

Coroll Hence also will the Body D
slide & y^e Body F roul upon the inclind
plain ABC (fig 4) to get to y^e Line CO
parall^el to its Line of Drection EG

Hence also will Bodies stand
fig 5 & 6. firme upon an horizont^al plain If their
Line of Direccon falls within their Bass
Thus the Body of fig 5 will stand and

that of Fig 6 will fall. A Bowle
pla 1 will easily change its place Because
fig 7 its Base being but one point Tis easy
for the Line of direction E G to fall out
of it This is also the reason why it
is almost impossible to sett a Straight
Stick or a Needle upright on a smooth
fig 7 Horizontal plain Because their Lines
of Direction E G fall out of their Bases
What is said of the Centre of gravity
may be also understood of ye Comon
Centre of Gravity of heavy Bodies as
we shall show in ye Ballance

# Of the Ballance

1st Propn: When a Ballance has its Bra=
=chia of ye same Length & weight The
power & the weight are Equall

2 prop Theorem Problm

To make an Aquilibrium wth
Fig 8 an Horizontal Ballance Let the weight
D be to the power E as the distance C B

of the power to y^e Distance A C of the
wright & So Vice versa Thus will y^e
Centre of gravity be brought under y^e
Centre of Mocon

3 Prop: By increasing y^e Velocity of y^e
power the Velocity of the wright is
Ejused as has been shown in the Sta-
=tera Romana

4 prop — THEOREM. Knowing
the wright of heavy Bodies applyed to y^e
ends of a Ballance of known length
to find upon that Ballance the Comon
Centre or Mocon

PROBLEM — A B the
Ballance be 24 inches long The wright
D 12 Ounces E 6 ounces To find y^e
fixt point where the Ballance being
suspended y^e wrights will hang in Aqui-
=libio Find a 4^th proportionall to 18:6:24
Which will be 8 inches for A C That y^e
As 18 the sum of the 2 wrights is to 6
the least wright So is 24 inches the whole
length of the Ballance to 8 inches Or A C
the distance of the fixt point from that

end of the Ballance w^ch has y^e biggist wright
E F.

Tho this is true in y^e Theory
pla 1 fig 9 Yet it wont hold in y^e pradtice Beam &
the Ballance A B w^ch we have supposd
without wright cant be really so Beams
y^e 2 Brachia are not of y^e same wright.
Hang the wright F to D - E at C (w^ch by
Axe 3^d) wont alter the Effect of the 2 —
wrights D E Thon hang at I the Centr of
Gravity of the Ballance y^e weight G to
y^e Ballance wrights Thon^e considering
C as a Ballance laden w^ch its 2 wrights
at its ends C I Find out O the comon
Centr of gravity as taught viz. F, G, G.
C. I. C O

5 prop. Probl Knowing y^e Length and
wright of a Ballance w^ch has at one of
its ends a Body of known wright To
find y^e fixt point about w^ch y^e Ballance
pla 1 fig 10 & wright of the Body shall remain
in Aquilibrio. Length of
the Ballance 12 inches
Wright of E Batt — 16 ounces
Wright of D — — 8 ounces
The sum of the wrights 24 ounces

Halfe the length of ye Batt — 6 inches
Fluid a 4 ℔ porcon to 24 : 16 : 6
wch will be 4 inches for A C That is as ye
wright of ye Body together w$^{th}$ ye wright
of the Batt is to ye wright of the Ballance
So halfe ye length of ye Batt is to A C
the distance from the wright of the Body
to ye Fixd point

6 prop Problem How to make a
Decit Full Ballance wch being Empty
& also laden w$^{th}$ unequ weights remain
in Aquilibrio

fig ii Let the lough A C be to B C as
the wright of the E to ye of the Scale D
The Aquilibrium will be kept If the Scales
are laden w$^{th}$ wrights yt have ye same
Ratio to one another As ii to 12
But the Trauel will be detected by
changing the place of the wright

# Off the Leaver

1 prop Theor — The Leav is —
reduced to ye Ballance The wright

pla 1

an Animate pow & Borng th: sam:
as y^e diff:nt wrights in y^e Ballance
& the Fixt point y^e same as the Contr:
of Motion

2 prop

Fig: 12: 13: 14: 15

(. tho 3 first propositions of th: Batt
are true concerning the Lever Cis th:
Fulcrum or fixt point, & the powr
applyd at B & D Fh: wright applyd at
A

Fig 12 Is a Lev^r of the first kind
as are also Leiors pinchers
Snuffers &c This Lever has the powr at
one end the wright at y^e other & the
Fulcrum in y^e middle

( Fig 13 Is a Lever of the 2 kind
as are all y^e Oares & Rudders of a
Boat, Cutting knives fixd at one end
and Doors moving on hinges Th: F:
Levers have y^e wright in the middle th:
powr at one end & th: Fulcrum at y^e other

pla 1
Fig: 12:
13: 14: 15

Fig 14 Is a Lev^r & of th: 3 kind
as are also Ladders that are taken

up by y^e middle to bear ag^t a Wall
This Law has the pow in y^e middle Betw^n
weight at one end & the Interum on y^e
other

Fig: 15 Is a Bended Lever or
of the 4^th Kind but it may as well be
reckond a Law of the first Kind Becaus^e
its Fulcrum is betw^n the pow & y^e weight
When you draw a Nail with a Hammer
it becomes a Bended Law

Fig 1 In a Law of the 1^st or 4^th Kind the
Fig 12 weight & the pow may be equal As it must
15 happen when A C is equal to B C The
pow may be gter then y^e weight as when
B C is gter than A C or y^e weight gter
than the pow As when A C is greater than
B C

In a Law of y^e 2^d Kind the weight
Fig 13 must be always gter than the pow Becaus^e
its distance from y^e Fulcrum will be
always less than y^e powers distance For
wherever the weight D is applyd A C will
be a part of B C & therefore must always
be less than its whole B C

In a Law of this Kind the pow must
always be greater than y^e Weight Because
& the distance of the pow will always be
less than A C of w^ch it can be but a part

N^a B^o: In all these Cases an Aqui=
=librium is Supposd

3 prop: Theorem A power w^ch pushes
or draws a Law at right Angles has greater
effect than at Obtuse angles

Demonstracon

Fig 16

Since y^e force of a pow depends upon
its distance from y^e fixt point & since by
(D: Fin 9) the distance of the pow is a Line
drawn Appendicle to y^e Line of direction It
is plain by Construction That C B y^e distance
of the pow applyd at r^t angles is greater than
C E the distance of it applyd at Obtuse or
C K the distance of it applyd at Acute
angles & drawing towards H I

Q.E.D since (by 15 di: 1^st Elem^ts

pla 1 fig 16 Euclide) CF. CL. CK, & CL (being pr of CB the distance of the pow drawing at C & and applyd at rt angles) is less than CB (by Ax 9: 1 El) Likewise CF & CK must be less than CB Therefore a pow applyd at rt angles has a greater effort than if applyd at Obligue angles

N.B. CF is ye distance of the pow E applyd at B & drawing at obtuse angles as ye angle CBE and CK is the distance of a pow still applyd at B & drawing in ye Line of Lat the acute angle CBI. Q E D

4 prop pla 2 fig 1 Theorem. If a pow & whose Line of direction is perpendicl to a Line parallel to ye horizon bears up by means of that Line a wright whose Centre of gravity is above ye Line it must be greater to bear it up when ye Line is horizont Then when it is inclind and ye wright raised & greater yt when ye wright is lower The Line of direction of ye pow always remaining perpendicl to ye horizon The reason of this is Because the Body O dos not hang freely from ye Line & to rest it is fixed For if it did

the distance of the weight would decrease in
the same proportion as y^e distance of the pow^r
does When the Lever is moved out of its horizont^l
position That is When y^e Lever FB (whr
FC is the distance of the weight & CB the
distance of the powr) is moved into the
position GD and the distance of the pow^r
at D becomes CN (by Dfing) the distance
of the weight would become Ch if the wrg^t
was to hang freely E But since y^e Body EOM
is fixed to y^e Lever it endeavo^rs to descend in
y^e line of direction OL drawn perpendicularly
downw from its Centre of gravity O wch causes
the distance of y^e weight to be only LC in=
stead of HC Therefore y^e Bodies Gravity
decreasing in greater proportion than y^e force
of the pow^r (for is a weight y^t hangs freely)
the Body O requires a less pow^r to bear it
up When it is fixed upon an inclind Lever
above y^e horizon Then when that Lever by
parall^l to y^e horizon

pla 2
fig 2

Likewise in the Lever AK if y^e
Body O or y^e weight was to hang freely from
F its distance would be FC, decreased in
the same proportion as C2 the distance of
the pow^r But since by reason of the Bodies

being fixd above the Lever the Line of ∠ H K
= H K Direction produced is K O & and
its distance C its Gravity must be C for
When by the inclination of the Lever it is
below the horizon. Q E D

fig 2 The Inverse proposition is
true if the Centre of Gravity of the
Body be below the Lever

IN the Demonstration of
this Theorem is y^e same as the other, a
sight of the fig is sufficient

Where you may observe y^t in y^e
Lever A E the distance of y^e wright is
M C Whereas it would be N C if the Body
should hang freely & in y^e Lever D C y^e
distance of y^e wright is C N Whereas it
would be C M if the Body should hang freely

fig 3 & 4 Q. If two carry a wright upon
or hanging from the middle of a Lever
he carrys most who is nearest to y^e
wright See the opposition in the 3 & 4 fig

Off the Lever or Ballance is
meant what Archimedes said of
lifting up the whole Earth if he had

a place to fix his Instrum^t And it was by this powers that he is said to have lifted th: ROMAN Ships

# Of the Pulley

## Prop: 1st Theorem When a pow^r

pla 2 fig 7 by wch all pulleys draws up a wright the upper pulleys are L:aw of the first kind and the lower pulleys L:aw^s of the 2^d kind

pla 2 fig 7 For in C E and B H the pow^rs are applyd at E & H the wright at C & B and the Fulcra are in y^e middle O But in J K and F G the pow^rs are applyd at J F. the wright at O & K G are y^e Fulcra

## Fig 5 prop: 2: Theorem An upper

pulley adds no force to y^e powr B:cause it is a L:aw of th: first kind w^h it's Fulcrum just in the middle And in such a case the Velocity of the wright is not diminished & consequtly that of the pow^r not increas^d

## Fig 6 prop: 3^d Theorem. A Lower pulley

takes off half y^e Velocity of the wright & so doubles the Force of the pow^r B:cause

whilst ten moves one foot. I. moves
two foot

Fig 7 Prop. 4th Theorem As one is to y^e
number of the parts of the ROPE apply'd
to y^e lower pullys So is the pow to the
wright

As for Example If the hand
A can raise but 10 pounds without an
Engine It will by help of the pullys of
Fig 7 be able to raise 40 or 1 hanging at A will keep in Equilib^m 4 to
hanging at the lowest O or in the place of
the Body D

Prop: 5th What a power by a Pulley gets
in strength it loses in swiftness So as it
does in all other Engines

# Of the Axle in the Wheel

Prop: 1st Theorem As the Radius
Fig 8 of the Axis is to y^e Radius of the Wheel So
is the pow^r to y^e Wright

That is As CD. AB, so is the pow^r
apply'd at A to y^e wright Or rather as the
Circumference of the Wheel = velocity of the
power is to the Circumference of the Axis =
velocity of the wright So is the wright to y^e pow

pla 2
Fig 10

Coroll: This is obsrod in Watchs
Whon the Radius of the Fuzt in the Which
incrdasis as the force of the Spring is wak=
ind That y Axis of the Fuz may be always
turnd round with y same force Whon
the Spring is shongest it draws at A —
Whon wookist at B

pla 2
Fig 10

Prop: 2d Theorem An Axis in
is a Law of the first kind
. AB the Radius of the Wheel bring the
distance of the power & CD the Radius
of the Axis bring the distance of the wright

By the multiplicaron of Wheels
an Hair may draw up an Oake by
the roots

So this pow are roducibls Whim=
=bles. Angers, Windlasses. &c

# Off the Wedge

Fig. 11 A Wedge is the most Simple of Mechanic Enguns and is a Solid Triangle, usually of Iron, to slide ag^t the parts of the Body it cloaves To understand the pow^r of the Wedge One of y^e flatt sides w^ch inclind to one another is to be looked upon as an Inclin'd plain & the other as an Horizontall plain And you must conceive that by the help of this inclind plain a power shall raise a weight w^ch without this Enguine it could not So much as beat up

pla 2 fig 15 In the Triangle DBC Rectangular at B represents a Wedge, D the point or Edge of it. B C the head & to be plainer understood Let D B y^e Length of y^e Wedge be twice its height B C & y^e Basis B D perfectly smooth So y^t being applyd to y^e Horizontall Superficies A B w^ch is also Supposed perfectly smooth Tho

DBC may slide upon that horizont plan
AB without any difficulty Now again
Let us suppose that ye weight E be hinderd
from going to A by the plan HIK perpendicr to ye horizont Which yet does not
hinder ye Wedge from sliding along the
Horizontall plan AB When it shall be
drawn or pushd from B towds E by a powr
whose Line of Direccon is parallell to the
horizon If then ye pow pushes the
Wedge DBC regularly from B tow A in
causing it to slide upon the horizont plan
pla 2 AB it will cause ye weight F to rise up
fig 15 so regular a motion That its Centr of
Gravity F will never go out of the Line
F.f perpendicr to ye horizon So yt when
the point B shall come to D The point C
to c & point D to G (That is When ye Wedge
DBC shall be in ye posicon GDc) the
weight E by ye resistance of the plan HIK
shall have been forced to rise by the inclind
plan CD or FG which will have pushd
it upw tow C So yt it will have risen
the whole length of the Line D f. When

E

tho pow shall have move y^e Longth of
the Line BD or DG Which is Twice DF.
by the Supposicon

Since thou in this Supposicon
the pow has doubl^e y^e Velocity of y^e wright
it ought to have doubl^e y^e force of the wrig^t
Therefore it must not be more than halfe
the Relative weight of that pondus
upon the inclind playn CD to be able to
bear it thro According to that Gondall
Law of Mechanicks w^ch we have taken
notice of in y^e Forgoing Engins Viz
That the pow^e inclin'd p^rcoually as
its Velocity do's increase Hence we may
easily conclude y^t when a pow^e whose Line
of Direcon is pall^le to y^e Horizon
sustains a wright by y^e means of a Wedge
whose Basis is also pall^le to y^e horizon
That pow^e is to y^e wright it bears up, As
the height of the Wedge to its Base

Corol Hence y^e sharper the Wedge is the
more easy it will enter Because GD
the Velocity will be Greater in p^rcon to

pla 2
fig 15

fig 12

pla 2
fig 13

# Scholium

The reason why a small Hamer with a violent Blow will not have so much Effect as a small Blow of a Sledge Is that a Sledge with a small force added to its Gravity will have more Mocon downw than a little Hammer with a swift Blow Becaus y^e Mocon is in a Ratio made up of the pondus & y^e Velocity

Fig 13

The Wedge may be reducible to the Lever thus. C B A is as two Levers of the first kind Whose fixt points are at B or rather As in the 14 Fig it represents two Levers of the 2^d kind whose Fulcra are in the Comon point A
The weights to be moved at C & the powers applyd at B

pla 2 fig 13

To this power are reducible Nails Bodkins Hatchets Knives Saws, Files & Biting Wedges fastned to Levers

Fig 17

# Of the Screw

The Screw is nothing but a Wedge

continued round a Cylind$^{r}$ E in a spi~~r~~ calld spirall
manner The Male Screw AB
is an Outside & the Female Screw CD
an Inside Screw

To shew better how y$^{e}$ Screw
works Suppose the wright F to move
upon y$^{e}$ Solid Triangle DCB
from E to C It will be y$^{e}$ same thing
as if the Solid Triangle had moved under
it & forced it up to F which must ne-
Because the Verticall plain HIK
hinders it from rising in any other
Line Besides EF. Now because
the power has moved the whole length
of the Line D & y$^{e}$ wright only that
of the Line EF. the power must be to the
wright as the length of the Line EF
which is the Velocity of wright is to y$^{e}$
length of the Line DC which is the
Velocity of the power

fig 16

To estimate the force y$^{e}$
Force of the Screw we must look upon
the height of the Cylind$^{r}$ HIPL
as the Velocity of the wright & the Thread

H K L M N O P (if its Helices
were inwound & layd at full length)
as the Velocity of y^e pow^r Therefore by
the force of Screw the Gravity of a
weight or any other pressure will be found
as much at y^e Spirall Line H K L M N O P
is Shorter than H P or J Q the perpendicular
height of the Screw

Corol. Hence the closer the Thread
of the Screw, The Gr^r will be its force
Because its Thread will be proportion
to its height & it will move y^e Slower

Scholium If long Levers
be added to y^e Screw, its force will be
still increased After the same manner that
was shewed in y^e explication of y^e Law

The advantages of this Mecha=
=nic^e Faculty is That Where as other
Mechanic Engines cease to act & the
weight returns When y^e pow^r does not
continue to act This sustains the
weight & retains all the force that
was Communicated to it When y^e first

pla 2
fig
2

Now we also to act Because the wright
prossing along the Axis pushes y^e threads
of the Male Screw ag^t thos: of y^e Female
Screw Whereas an Helicall Mocon
is required to unscrow So much as is
screwed up of the Instrum^t

Now in other Engines As in a
pulley for Example or Lever The wright
will returne as Soon as y^e Hand ceases
to pull & Rope or press upon y^e end
of the Lever But thou there is this —
disadvantage Viz That a Screw is
screwed up as far as it can go in a little
time Which Inconvenience may y^t
be remedied in Compound Engines
If you make it a perpetuall Screw &
apply it to a Wheel as in y^e 9^th fig Where
the perpetuall Screw CE fixed to the
Cylind^r AB takes the Teeth of the Wheel
F. and turnes it continually the same
way till it has by means of its Axis —
drawn up the wright G Thro' so dist^t
at first —

Fig: 9

That this Powr is rodnicibto to
a Lawr appiares from its being a Wodge
wch we have showd to be made up off two
Lawrs of the first or 2d Kind

# The First Law of Nature

is That all Bodies endeavour to pserve
yrselvs in ye same State or their Mocon
or rest So y if the Body be at rest it nevr
cows off its own accord to Motion
But must have somthing to move it
And if it be one in mocon it endeavo to
pr just in that Mocon always according to
the same direcon in ye same streight Line
Nor can it be stopt but by a Force equall
to ye Force of its Mocon

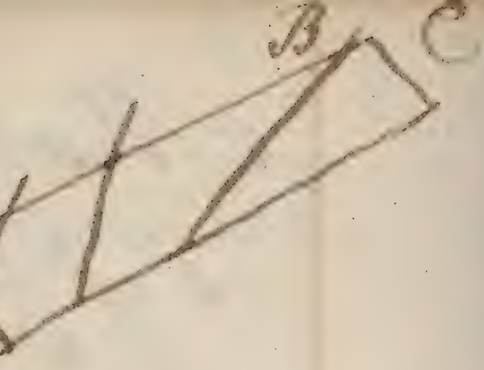
This is playn For Bodies being
of an active Mas or Matter can
acquire no Change or mutation of their
own State & a Body can no more change
its Mocon & come to Rest Then it can

change itself from one figure to another
after y^e same manner it can never
change its Direccon But will always
continue to goe forw^d in y^e same streight
line But wher ever Change is made in a
Body must be by some extrinsecall
Agent And if a Body ever changes
its Direccon there must be some exter=
nall Agent to make that Change of
Direccon & if it were left to its self it
would always move Uniformly
forw^d in y^e same streight line

If a Body move in any Me=
=dium it must necessarily thrust away
parts of the Medium that are in its
way And therefore since wher Moccon
it communicates to them it must loose
itself A Body that moves in y^e
Air must continually loose of its
moccon Whereas if there was no Gra=
=vity or no Air A Stone once throwen up
would goe on in Infinitum without
loosing its moccon The Air then is the
only Cause Why Bodies loose off their

Mocons whon throwen up & Gravity
is ye only Cause wch brings them to ye Earth

In the Heavens whore
the Ether is exceeding thin & most
degree to nothing the Planetts pro-
thoir Mocons wch the least Sensible
Diminucon From hence we know
the way how Mocon is communicated
to Bodies For whon a Man holds a Stone
in his hand the Stone participats of the
Mocon of his hand Bcause being in it,
it is moved wth ye same velocity as the
hand is Now by this Law of Nature a
Body once put in Mocon will always
endeavour to goe forw according to the
pla 3 same direccon * * * And therefore when
Fig 3 the Man draws back his hand without
ye Stone The stone having once a Mocon
forward will always endeavo to continu
in it Bcause all Bodies affect to moove
in a Streight Line Ther must necessa-
rily be some Force to make them moove in
a Crooked one This Force may be either
a String by which they are tyed to the Centre
of their Mocon or some other Subsistant
Force Such as Gravity wch continually
presses their Mocon to the Centre




a B C Suppos a Body put in
motion at A it will indeavo
to move in y^e^ said str^t^ Line
A B But y^e^ force of Gravity continually
pressing it tow^ds^ the Centre That is from B downe
or in a Line perpendicl^r^ to y^e^ Earth will move
in y^e^ Diagonall of the paralellogr^m^ if
you fill it up

When the Bomb C is by the force
of the powder driven out of the Mortar
it indeavo^rs^ by the first Law of Nature to go
on in y^e^ right Line c e But Gravity
acting upon it in the dirc^on^ a b makes
it move in the line c b Diagon^l^ & of the pa-
rallelogr^m^ contained under the Line c e e b
(That is supposing to other Lines to be drawn
and 11 to y^e^ said Lines c e e b) by a motion
compounded of the force pushing tow^ds^ a
from c and that w^ch^ pushes tow^ds^ b from c
Thus the Bomb would by the 1^st^ Law of Nature
continue to go on tow^ds^ d in the line b a
Being the aforesd Diagon^l^ & produced But
Gravity acting upon it in y^e^ dirc^on
g f makes it by a Compound motion go in
the Diagon^l^ b f of the new paral.logram
contained under b g & g f and so on till it
comes to y^e^ point h. Now since the

first Impetus & Gravity dont act alternately but at y^e^ same time all^y^ while the Bomb moves We must suppose the 2d Diagon^ls^ (in w^ch^ the Body moves) to be infinitely small & thou all of 'em together will make up the Curve c b fh called a parabolick Line in which all projectiles moves

pla 3 fig 5

The Swifter a Body moves in a Circle the stronger is its Endeavo^r^ to move in a straight Line & y^e^ more the Thread will be stretcht by w^ch^ it is kept in. The force by w^ch^ it stretches the thread is called Centrifugall force (as it is easily soon in Slings) and the force of y^e^ Thread w^ch^ detoyns it must be just equall to this Centrifug^l^ force But if Gravity or any other Centripetall force detains the Body in its Orbit the Centripetall force must be just equall to y^e^ Centrifugall That the Body may be kept in the same Circle

If a Body lye upon a Table & the Table be moved At first the Body will not partecipate of the Motion of the Table but will soon to goe the contrary way As

is plain from a Vessell of water set upon
a Table But after the motion
is once communicated, if you
stop the Table suddenly the
Body lying on it will continue its motion

If a round Table pall to ye Horizon
be turnd round an Axis & a Bullet by
the help of a Thread bound fast to its Cen-
tre. Tho the Thread be slack at first yet after the
Table is turnd round the Bullet will
recede from the Centre & stretch the thread
as at D, If the Table be stopt on a sudden.
Yet the Bullet will for some time continue
its motion if the bullet be not put upon
ye Table but hang down by the thread
As in the posture A B after ye Table is
turnd round the thread will not keep
its perpendicl position But will settle it-
selfe in the position A b Tho Centrifugal
force acting agt the force of Gravity
& making ye body recede as far as it
can from the Centre of motion

If a Glass Tube be layd or fastnd
to a table in which near the Centre be put a
small Bullet When the Table is turnd

round we may observe the Ball to
recede from the Centre tow^ds the Circumference
& accelerate its motion

Besides this it will go^r ag^t the
common Law of Gravity & move upwards
If y^e Tube be set Slanting upon on the
table being first fixt to a piece of wood
represented in fig 4 plate 3 and it will stay
at y^e upp^r end of the Tube beyond Has long
as y^e table is continued in its swift mo-
= tion But when that ceases it is prest down
again by its own Gravity to G

The same is observed in wa-
ter Globules of Mercury or Wat^r in the
Tube If wo fill y^e Tube with water & put a
piece of Corke in the end of it w^ch is next
to y^e Circumference We may observe
that after turning round the table the Cork
will get from y^e circumfrent tow^ds the
Centre For the water being more Dense
or consisting of a greater quty of matter than
y^e piece of Corke of the same bulke it will
have a greater Vis Centrifuga or a strong^r
Conatus recedendi a Centro, than the Cork
has And consequtly the Corke w^ch has much
less force will be prest by the water w^ch has
a greater force tow^ds the Centre

# The second Law of Nature

is That the Mocon produced & the mutacon of mocon is always ꝓporcon to yᵉ Mocon impᵣ=
ssd wch gencrals that Mocon a double Force
will produce a double qtity or Momentū
of mocon & a Triple force a Triple &c and
this mocon will always be according to the
dirccon of the force wch impressis it and
if the Body was movd b4 fore this new
Mocon arising from this new force it
will either increas its mocon if it act
according to yᵉ same drccon or dimi=
=nish it, if it act in a contrary drccon
or if it act Obliquely it alters the drccon
and turns the Body another way

If a Body be once put in mocon
By the first Law it ought always to go on
with yᵉ same velocity & in yᵉ same drccon
But if a new force equall to the former act
again upon it according to yᵉ same drccon
its mocon will be increasd doubly If again
the same force act its mocon will be Triple
of the first &c This if

A C D E B A was put in mocon towᵈˢ B having
once acquird an Impetus, That way
it would always continue in it But if

we should Suppose that w^n the Body comes
to C that y^e same force acted again upon
it It would produce a mocon equ to y^e
forc & both those put togethor will be
pla 3 double w^th the first Again when the Body
fig 8 comes to D if the same force should act
again upon it there would arise a new
qtity of Mocon equ to either of the forc
& y^e whole being put togethor will be Triple
with y^e first Mocon If again when the
Body comes to E, the same force acted upon
it It would again produce more Mocon
which would be equ to y^e first & y^e whole
Mocons arising from all those Accons
put togethor would be Quadruple with the
first If this force they acting imprinted
on the Bodies equ dogs of mocon at equ
Intervalls of time the Mocon produced &
consequtly the Velocity will be as the num-
= ber of acting upon it at first gives it a mocon
downw^ds Now if the Body should cease for
ever after to be heavy, yet the Body will
go on in the same direccon & with the
same Velocity by the first Law But then
in the second instant of time the Body is
heavy & Gravity continues to act yt

will again produce a Moon equall to
y^e former Just so If the Boby were
after should ceas to be heavy yet it
would still continue its Cours. & w^th
y^e acquird degr^s of Velocity But thon
Gravity acts y^e 3^d instant of time after
the same manner it did at first &
makes a Moon equ^tt to y^e first degr=
& therefore y^e Sum of y^e whole will be
Triple w^th the first after thos same mann
the Moon the fourth time will be Qua=
=druple of wt it was the first Instant &
so y^e Moons will always increase w^th y^e
times

pla 3
fig 8

This is y^e reason Why we find
Bodies in their descending Accelorate their
motion. When Bodies fall, the Spaces
thro w^ch they descend are the Squares
of the times they take to fall in Always
accounting from y^e Beginning this

If in the first minute of time a Body
fall thro a certain space at y^e end of the
2^d minute it will have descended four
times that Space In the end of the 3^d —

Pla 3 Fig 7 minute It will have descended three times the space wch it goes thro in the end of the first

So if the times be taken in Arithmetickall progression of 1:2:3:4:5:6 Thou the Spaces thro wch the Bodies will have descended at ye end of those times will be as 1:4:9:16:25:36:49 &c

If it be askt How farr the Body moves in the 2d Minute, twill have moved just 3 Spaces For it had moved thro one in first & so likewise in the 3d minute It will have moved thro 5 For at the end of the 2d minute it had moved thro 4. Take 4 from 9 & there remains 5

The 2 Rectanglar Triangles of Fig 7 made up off the Rectangular Tri=

Pla 3 = Fig 7 angles represent the Spaces gone thro in a determinate time Each single Triangle denoting one Space As for Example In the upper Fig marked 7 if we suppose a falling Body to fall out at ye rate of one Mile in one Minute Let the number 1 & the perpendr of the little Triangle at top express the 1st or minute & ye same Number 1 and the Base of the said Little Triangle express ye Velocity wch always

is at 8 minuts & so of whole Triangle
expres one mile that y^e Body fell the first
Minute Thou if you consider That the
Body having fallen 4 minuts The line ex=
=prising 8 minuts must be the perpendicular
of the Great Triangle Which is 4 times —
greater than that of the little upper Triangle
Likewise the Line expressing the Velocity
must be the Base of the great Triangle —
Which Base is 4 times greater than the Base
of the Little Triangle & y^e whole Triangle will
be the Sum of the spaces or miles gone thro
in 4 Minuts Which will appear by dividing
it into little Triangles equal to y^e first. A
sight of the figure will easily teach how
to know the miles that y^e Body has fallen
thro in any number of minuts or time

Fig 10

If a BODY as A lies upon an
Inclin plain it endeavo^rs to descend
perpendicl But y^e plain hindring it w^th
part of its weight it will press upon the
plain & with y^e rest it will descend as
fast it can along the plain But it will
not Accelerate its motion so fast As if did
all along descend perpendicly This in
falling from B to C it takes long time than

if it had gone directly from B to D in the
perpendicl Soy at y^e point C it would have
as much Velocity in falling from B to C
As it will have at D in falling from B
to D The loss the plain is inclind to the
Horizon or y^e nearer it comes to the
perpendicl The faster it will accelerate
its Motion — Hence it will fall from

fig 11 B to G Thon from B to C
and sooner from B to E
than from B to F but in
falling from the same point

C to the points D E F G C the degr
pla 3 of Velocity acquird are all equ the they be acquird
fig 11 in indefinall times V: G Imposs:
B C 3 times longer than B D. The Body
will go from B to D in y^e 3^d part of the time
that it goes in y^e plain of B C from B to C
But the Velocity acquird in y^e descending
from B to D is the same that is acquird in
y^e descending from B to C therefore it
will accelerate its motion in the Line B D
3 times faster than in the Line B C

If a Body in falling from B to
D acquire any degree of Velocity & with

that Velocity it co turnd It will just aſcend
to the same hought from wch it fell and
Gravity acting upon it will Lykewise con=
tinually its Velocity in the same proportion
it increasd before in descending & after
it has come to y point B it will immediately
begin to descend again after y same manner
As having fallen along BD it co turnd up
in the inclining plain DC, wch the velocity
pla 3 acquired in descending it will just go to
Fig 12 the same hought from wch it fell

Fig 14 If a Body B hanging by the String
AB down tow D C be mobd from B to D &
from thence let fall It will
continually accelerate its
Motion till it comes to the
point B or E & then w all its
force it will go in to the Arch
B C to y point C of the same
height with the point D from wch it fell &
that at y point C It will descend to B &
there it will have y same Velocity as
it had before at B. With wch it will ascend
to D & so make Vibration continually
The Body so hung by y String is calld
the Pendulum Suppose a Circle

whose Plain is perpendicl to y^e Ho-
= rizon In w^ch were drawn soveall Substans
BD, BE, BF from the lowermost point
B the Body will descend in the same time
pla 3 along the Line BD from D to B that
fig 9 it will along the Line EB from E to B or
along the Line FB from F to B. The
reason is this The the Line FB is long
thou the Line BD Yet it is also more
perpendicl or less inclind to y^e horizon
& consetly the Body will accelerably
Move faster upon the Line BF then upon
y^e Line BD Becaus smeall Arches do
not differ much or thor in decurty
or length from their Chords. Bodies
will very nearly descend in y^e same
Arches of Circles that they will do in
the Chords of those Arches But Bodies
descend in y^e same time thro all those
Chords Whether they be gter or less & by
consequence the Vibrations of the same
pendulum Whether it run out in a
gter or a less arc are all performd in the same
time
fig 16 Let A fall from 8 & B from 4
The Velocity w^ch A will be moved being

so much greater than that of B they will both move exactly at y^e^ point C The short & the Strings are the quick are the Vibracons B. cause the String is as the Halfe Diamitor of the Circle & So the less the String is the lesser the Circle will be & consequtly the less the Circle is the quicker the Body will move round it

## The 3^d^ Law of Nature

Is That Action & Reaction are always equall & Contrary (viz) The Actions of Bodies one upon another are equall & the force imprest is always directed tow^ds^ contrary parts So y^t^ the Mutacon of motions in those Actions produce an Equ^ll^ This Law will be illustrated by several Examples First If the Body A (A) (B) C moving tow^ds^ C meet with B at rest W^ch^ for Mocon the Body B gets by the Impulse So much precisely will the Body A loose. V. G. If the Body A have 12 degr^s^ of Mocon & after the

impulse B have 5 Thou A will have
bit 7 remaining & therefore will be
Equ entitled of moon in both & the
effect will be y^d same As If a Force equi=
=valent to 5 degr of Mocon acted upon A
tow^ds D contrary to its form moon &
another equival^t to it acted upon B
Impelling it tow^ds C & Universally when
one Body hits another the Stroke or Blow
is equally recd in both & it is always pro=
=portionable to y^e Mocon lost in poreu=
=rous Bodies If an horse draws a
Stone 10^ch is tyed to a String th^e force by
10^ch the horse is pulled back tow^ds the Ston
is equall to y^e Force by 10^ch th^e Stone is
drawn tow^ds th^e Horse For th^e Rope being
equally stretcht by the same power it
has to contract it self will pit equally
th^e Stone tow^ds the horse And th^e horse
tow^ds the Stone & therefore th^e force of
pla 3 Attraccon in the horse & in the Stone
fig 18 are both Equ^ee But setting the Strength
of the Horse is so great & assisted by th^e
ground on w^ch he stands & that he can=
=not list the Attraccon of the Rope he will

not in the least yeild to the attraction of the Rope nor be pulled out of his place But y^e Stone will has not so great a force of resistance will be drawn to y^e Mag^r. If the Magnet or Loadstone attract Iron The iron will likewise equally attract the Loadstone This may be soon If you hold y^e Iron in a fixt point & y^e Loadstone hang in a Scale or be suspended by a String

The same thing is true in oth Attractions

pla 3 fig 18

Suppose 2 Boats A & B floating on y^e Water & a Man in one of y^m (V. G) A by the help of a Rope pulls the Boat B towards him & by y^e Attraction not only the Boat B comes to A but also the Boat A will be equally drawn to B So that y^e q^tity of motion will be equal in both & if the Boats be of y^e same weight & bigness they will meet at the Midway betw A & B

But Suppose B ten times greater than A Then B will have ten times less Velocity y^n A & the Boats will not meet

at E but D so y^t G D will be 10 times long
thou F D If B is 1000 times gter thou
A they will moot at y^e point D ch w will
be such that G D will be 1000 times gter
thou D F & consequently it ought to have
1000 times less velocity So as to make y^e
Momentum equall in both But if B be
vastly gter y^n A its Velority will be vastly
less & altogether insensible If a Man in
A by y^e help of a pole thrust the Boat B
from him tow^ds H By that thrusting the
Boat B forw^d the Boat A will be thrust
backw^ds tow^ds K So y^t thou will be equall
qtities of mocon in both tow^d contrary
parts And therefore if B is 10 times gter
thou A. B will mov tow^ds H with 10 times less Velo=
= city then A w^ch moves the contrary way
tow^ds K So y^t tho qtity of mocon in both
are equall

If B is immensly bigg thou A
its Velority will be less then A's in the
same proportion & consequently it will be alto=
gether insensible in respect of A's & may
be reputed as none

And therefore if a Man in a boat
thrust the Earth or shoar from him the
Boat by this thrusting will recede from

the Shoar For the Shoar may be consid^d
as a prodigious great Body in respect of the
Boat & consequently its Velocity will vanish
& be Equival^t to nothing

Fig 17 When a boat is rowd w^th Oars the
Water by the mocon of the Oars is repell^d
back to C & therefore will react upon the
Oars & give to the Boat tow^ch they are fixed
a mocon tow^ds D and its only upon this
acc^t that y^e boat advances forw For if
there was no Re-action & y^e Water
by being thrust back did not give the boat
a mocon forw^ds they must stand still Becaus
there would be no Cause for its mocon
But now since the water roules upon
y^e Oars it communicates by its Reaccon
as much mocon to y^e Oar forw as the
Oar did to the Wat^r backw^d

Since Swiming is nothing
but Rowing w^th foot & hands We may easily
understand the reason Why by this mocon
of our hands & foot we advance forw For
when y^e Wat^r is thrust backw^d it by Re-
-accon will repell y^e Swimer forw Likewis.

which by the motion of our hands we throw
y^e Waters down It by Reason will ### ###
### ### force upon And y^e same
thing is to be applyd to y^e flying of Birds
& is nothing but Swiming in the Air

For a Rule that all
Bodies observe, in their motion is this The
Sum of their motions tow^d the same ple
w^ch is known by taking y^e Sum when the
Bodies move the same way & the differens
(when they move contrary ways) remains
the same always before & after their mutuall
Impulse

$A^{th}_5$ $B^{th}_5$

$v_8$ $v_6$

m 40 30.

Moon after meeting 40 / 30 / 10 = diff

Diff of Vel $\frac{6}{2}$

$\frac{1}{2}$ of it — — 1 = to Vel

After meeting

Sum of $v^t$ wi$^t$ . . 10

Vel$^{cs}$ aft wi$^t$ . . 1

Moon 10 = 10 th diff of motion

$A^{th}$ $B^{th}$

$x^5_8$ $v^5_6$

40 30

Diff $\frac{10}{10} = 1$

$A^{th}$ $B^{th}$

$v^{10}_5$ $v^6_3$

50 18

18

Diff . . 32 Divide th Sum of thr Bodies

Quotient 2 Common Velocity aft wi$^t$

Bodies that have no
Elasticity after thos Congress move
together without any Impacon tow that
is do where was most Mocon & becaus
thos sum of thos mocons is alw^s thos sam
before & after persussion If we take the Sum
& divid it by thos qtity of matter or weight
of the Bodies The Quotient will
give thos Comon Velocity with w^ch they will
move after thos Conjunccon Suppos
A & B equ^ll each For example Lo a Body
of 5 weight & suppos B at Rest & A to
move tow^ds it with 4 degr^s of Velocity Be=
=cause B had no mocon thos sum of thos
mocons will be 4 times 5 or 20 Which
being divided by thos sum of thos weight
viz^t to y^e Quotient 2 will be thos Comon
Velocity after Conjunccon So y^t if one Body
move directly upon another equall to
it w^ch is at rest after thos Conjunccon they
will go forth with half their form Velo=
=city If A & B were equ & B was move

according to ye same direction w.th A bit
with less velocity after their Conjunction
they will both go together with half ye
sum of their velocities Suppose As
velocity 8 & B's 6 after Impulse the velocity
of each will be one If B moved by a contrary
direction w.th less motion should has this
if the Bodys be equall they will move togeth.r
with half their difference after meeting
But universally their Velocities are de-
= termined by taking the difference of their
motions Which is the sum of their motions
towds the same direction & dividing it by
the Sum of Bodies

Suppose A to be 10 & B to be 6
Let A's velocity be 5 & B's 3 The difference
of their motions is 32 w.ch being divided
by 16 the sum of the Bodies the Quotient
2 is the common velocity after meeting

If A & B moving contrary ways have
equall ratios of motion after Encounter they
will both rest For in this the difference
of their motions bring nothing after meeting
they can have no motion As for Example
Suppose A 10 & B 8 Let A's Velocity be 4

& B$^{s}$ 5 In this case the Moton in each will
be 40 And thirobeing no differonce of motony
this equall & contrary forces acting one
upon another will destroy one another's
motion And therefore Cartesius's Law
of motion is fals. By w$^{ch}$ he said There was
alw$^{s}$ the same Quantity of Moton p$^{r}$served
in the world

pla 3
fig 15

There were no Elasticity
the four Laws would serve for all Bodies
But by reason there are few Bodies but
what are Elastick the Rules of common
Motion are sometimes very different
from those already given For by the force of
Elasticity of Bodies sometimes they move
after pension & according to y$^{e}$ same
direction & sometimes they go in contrary
Direction That we may explain the Laws
of & separation of Bodies &
may illustrate it by an Example thus —

Set A Bropient
a Silken Thread or Catts
gutt strond & strongly
extended upon the Table
by the help of 2 Nailes If the thread be take
by the middle point & moved out of its place
to y$^{e}$ the point D comes to C & y$^{e}$ Thread
lyes in the position ACB & then left to
itself It will immediatly with force go to

restore itself to its forⁿ E posicon Now
by the continuall acting of the Elastick
force by wch it endeavo to restore its self
It will continually increas its Velocity
just as heavy Bodies doe & when it comes
to y^e point D it will have a force to go on
forw^d equall to that by wch it was forc'd out
of its posicon By wch motion it will go
on till it comes into the posicon A E B
& then it will restore it self again & perform
Vibracons just as in a Pendulum
Now let us suppose a Body F to run upon
the thread A B the thread by this force will
be put out of its posicon A B into the
posicon A F. B where it will quickly stop
the motion of the Body D Now the motion
of the Body D being destroyd the Thread by
its Elastick force endeavoring to restore it
self will return to its forⁿ E posicon w^ch
the same force by wch it was put out of it
& will bring back y^e Body D again w^th
it & when it comes to the positon A D B
twill have y^e same force to go forw^ds towds
F as it had w^n it was putt out of its po=
=sicon first But w^n it was put out of its
posicon first it had all the force of the
Body D impress on it for all that force
was spent in bending y^e Thread —

Therefore it will restore its Sph to all that
force & constantly drive the Body D backwds
by the same forces — — with wch steam
upon it The Body D having thon once
gott an Impulse backwds equall to wt it had
at first forw will by the first Law of Nature
alw continue in that mocon & ytfore
will be reflected wth ye same Velocity it
had at first If the Thread dos not restore
its Sph with the same force with wch it
pla 3 was bended ye Body will not be reflected
fig 13 with ye Velocity equall to wt it had at first

If the Body run slooping upon ye
thread the reflecion will be Obliqul So ye
the Incident angle B be
equall to ye reflected angle
& if instead of the thread there was placed an
Elastick Body & suppose its Surface bended
in by the force of the stroke from the posicon
AB into the posicon AB assoon as
ever ye force of the Stroke ceases the Surface
ACD by the force of Elasticity will be restored
into its former posicon & by ally ye force by
wch it restores itself it will act upon the
Body F & make it move back again Now
if the Body be a perfect Elastick Body it will
restore itself with ye same force with wch
it was compressed & ytfore it will make

the Body I rocdo from it with ye same Velocity
with wch it at first it advanced towds it

Now that all reflecting Bodies as
Glass Ivory Marble &c are Elastick may
be easily concluded from y^e Sound and
tingling wch they give w^n they are struck
Just as in a Silk or Line string w^n it is
stretchd & struck they produce an Undu-
=lation in y^e Air caused by frequent Vibrations
after y^e same manner but not so lasting
But it may be more easily proved from the
Concourse of Glass or Marble Spheres For
if you tinge one with any Colour & let the
other fall upon it the percient Body
will have a portion of its Surface tinged
then that wch it ordinarily touches &
therefore by the Stroke it must be some wt
flatted Tho affords it restores itself again

Bodies that are perfectly Elastic
recede from one another after Impulse
w^th the same velocity as before they struck
& approached one another Or (wch is the
same thing) their Relative Velocity
before & after their mutuall pulsion alters
y^e same The reason is this Bodies recede
from each other only by y^e Elastic force
By wch they restore y^mselves to y^e first
figure but y^t force is equ to y^e force of the
Stroke by wch the figures were changd & y^

Stroke is alw's in ꝓpcon of the Velocity by wch they approach one another & therefore ye same force will make recoil from each other with the same force as they before came to each other If the Bodys move towds contrary Direcons the force of their stroke is as their Relative Velocity wch is equl to ye Sum of both ye velocities But if they go on in ye same Direcon the force of ye stroke (wch is still as the relative velocity) will be likewise as ye difference of their absolute Velocities For the Relative Velocities are alw's as the Differ= = ence or sum of their roall velocities according as Bodies move in contrary or ye same direcons

From this propty of Perfect Elastic Bodies & ye universal Law of motion That ye sum of their motions towds ye same Drecon alw's remain ye same Tis easy to determine the Velocity of each of the Elastick Bodies after pcussion

The Rules wch they observe are these following

1 / If a perfect Elastic Body comes upon another equall to it & at rest After pcussion the pcentient will

stand still & ye othor will go forwds wth
all ye Velocity of the pentient

2 If 2 equall Elastic Bodies move
according to ye same Direcon After Con=
= cours: they will change their Velocitys —
one wth anothor & the Antecedent
will have the velocity of the Consequt
& ye Consequt of the Antecd

3 If 2 Equll Bodies move contary
after meeting they will both reflect and
change their Velocitis one with anoth

4 If a little Elastick Body
comes upon a gtor wch is at Rest the
Impinq Body will be reflected & the
other will go forwds wth a mocon equll
to both the Mocon of the Impinq forwd
before the Impulse & its mocon backwd
after

5 If the Gtor body comes upon
a less they will both move after the
Stroke in ye same Direcon

All that underStand Al=
= gebra may easily calculate the velocity
of all sorts of Elastic Bodies aft ye unthinkt Contrys

# Hydrostaticks

## Definitions

1 A Fluid is a Body whose parts yeild to any Force impressd, & by yeild=ing are easily put in Motion.

2 A Solid is a Body whose pts are so connected As not to be dividd w^out a determinate force. By Solidity, we don't mean that ppty of Bodies, whereby they resist Penetracon, But that Cohaerence of the ptes by w^ch they endeavo=r not to be sepatd.

Mons^r Ozanams Difinicon of a Fluid & a Liquid are these;

A Fluid is a Body wch is easily pasd thro, & whose sepated ptes joyn again immediatly; As Air, Flame, Water, Oil, ☿, & other Liqus.

☿

A Liquid is a Fluid, wch being in a sufficient qtity, flows continually

and spreads itself below the Air, till its upper surface is Level, or in an horizontal position.

3 Gravity, is that force wch pushes Bodies downwds.

4 One Body is said to be intensly, or Specifically heavyer than another, when it has more Weight, & ys same Bulk; Or as much weight & less Bulk. Let A be an inch of wood, & B an inch of Lead; if B weighs 4 ounces & A one ounce; B will have 4 times more specifick Gravity than A.

Let A, be an ounce of wood, & D an Ounce of Lead; if A be 4 times q^tr then pla 3 fig 19 D, Then D will have 4 times the Specifick gravity of A; For there is a reciprocall proportion betwixt the Bulk & specifick Gravity of Ponderous Bodies

## Prop. 1st

Both the Superior & Inferior ptes of any heavy Fluid are heavy, & the Superiour pres^s upon Inferior by its gravity.

Let a Fluid be put in y^e vessell ABCD,
I say all its parts are heavy, & that the
sup^r^ce pt^s A E F D press the Inferiour.
since the whole Fluid is heavy by the Hypo-
=thesis, & the pt^s p^t^ake of y^e nature of the
whole It appears that all y^e pt^s are heavy.
Wherefore since Gravity is that force wch
pushis Bodies downw^d, It appeares also
that this force is exercised on y^e Inferiour
pts of the Fluid wch are therefore prest
by the Superiour E. Q. D.

pla 3
fig 19

## Coroll

From hence it follows y^t y^e pressure
on any parts of a Fluid is alw^s according
to y^e height of the Incumbent fluid For
the Sup^fic^s E F is prest by a E F D & y^e Su=
=perficies G H by a G H D whose weights
or pressures are at all G

## Experim^t

Take a Glass Bubble & having by heat
expelld most of the air out of it; Immediatly
Seal sott it hermetically When tis cool try
it to a ballance & add so much wright to it
as will make it sink Then put wrights into
the other Scale to keep it from sinking Then
break off a piece of y^e long neck of the Bubble.

within the wat Lo y^e wat^r may run in &
you will find that y^e wrights in y^e other
Scale will not keep the Ballance eavn
Whereas if the wat^r within the Bubble did
not weigh The whole world still be kept
pla 3 in Aquilibrio Becaus according to that
fig 25 Supposicon there is no addicon of Matter
that weighs Hence is plain y^t Wat^r
weighs in Water

## Ad Cor prop 1

On this prpō are formed all Water
works & Fountains. aworing to the
height of their Reservatories so high
will Water rise. V: G: If the Reservā=
tory be 20 foot The sported water will rise
20 foot allowing for y^e resistance of Air

Fig 25 If you tap a Barrell full of
Wat^r at several all places the highest will
sport out the least way Becaus its height
from the Surface is y^e least & consequtly the
pressure is the least That wch is lowest
will sport furthest Becaus further from
the Surface & therefore the Stor prosumi
will be upō it

But this must be understood If the
Barrell be a sufficient height above the Plane

our w^ch it spouts As in fig 25. pla 3. For
if the Barr should lye upon an Horizont^ll
plain the Liquo wch comes out at the middle
of the hole would spout further Because the
the liquo comes out at Bottom w^th the greatest
velocity the plain would intercept it at a
less distance from y^e barr then if the barr
was higher In such a case y^e liquo spouting
from an hole as near the Level of y^e surface
of y^e liquo in y^e barr as y^e distance of the
lowest hole from y^e Level of y^e plain on
wch it is to spout will fall on y^e plain
in y^e same place as the liquo that comes
out at y^e lowest hole

To know exactly how farr
the liquo will spout out of a Barr^ll pierced
in any determinate place Make the
following Construccon D L represents the
plain on wch the liquo is to spout. D I
is the distance from the top of the liquo
in the Barr^ll to the Level of D I From y^e
Centre A^ye middle of E D draw the Semicircle
E F G H D Then mark on y^e line E D
the distance (from y^e surface of y^e liquo
at wch you would tap the barr^ll As for
Example The point B A or C From
any of those points raise a ⊥ till it cutts
the Circumference E G D as at F G or H

Sett off any of those lines as AG twice upon
ye line DL from D: towd L as DK & that will
be ye place on ye plain where ye liquo will
fall Spouting in the Curve AK. If there-
= fore B & C be equally dist from E & D, BF
will be equall to CK &
those two lines being sett off
twice upon DL, I will be
the place where ye spouted
watr will fall on ye plain
DL Whether the Spout be tapt
at B or at C Forasmuch as
the Spout CL has more
Velocity ye the Spout BI So
much is CJ sooner inter-
= cepted by the plain then BJ

Fig 26 If the Spout of a Bar be turnd upwd
pla 3 the watr will rise as high out of it upto ye
fig 19 height of ye watr in the bar viz to A and
as ye watr sinks so will the spouted watr
without sink too

## Prop: 2d

In any Fluid as ABCD not only
the pts are prest downw Bt there is
also a Lateral pressure & a pressure fro all pts

For when a Fluid is prest from all sides it endeavo to recede from that pressn. from whence that force of recoiling will prove all Elementary Bodies Whether Fluid or hard Q: E: D: Let a drop of water as a be prest by the finger D upon y^e plane BC It will not only prove y^e plane BC but also endeavo to recede tow^ds the plos B & C & if there be any Body as f wch hinders it, vdeo on It appears y^t that Body is prest with all y^t force By wch it endeavoos to recede tow^ds B

After the same manner in the Fluid

fig 20 a b c d Let any pl^e be assigned as a wch by the foregoing prop^n is prest by the upper fluid & endeavo^s to recede tow^ds the plos B & K Therefore it must needs be that it prests B & K w^th all that force by wch it recoils towds those plos Q E D

Cor. Hence Later^l pressn. is according to y^e height of y^e Incumb^t Fluid

Scholium Hence is easily understood why Flasks well stopt and only full of Air being let down into the Sea (by some weight tyed to them) are broken Viz^t by y^e gt weight of y^e incumb^t Water wch wanting the Spring of y^e flasks nor y^e included Air is able to resist

Fig 24

# Experim 4

If you intro: a Glass Tube in
wat & stop the open end w yo fing to hinder
the Wat from falling out of it again and
immediatly take yo Tube of wat & put it a
pretty way into a vess of Oil So yt the
uppermost Surface of y wat may be below
the Surface of y Oil The oil will force the
Water up Dery Oil at E & bring more prest
by the Column of Oil G & H then it is by
the Incumbt water at M will be force
11 pods & it will make y Water at M to
ascend till the Fluid in the Tube presses
as much on the Surface M as y Oil at G H
dos on y surface E F.

## Non Brans: Water is heavyr
than Oil tho wat in y Tube will not rise so
high as y Surface of the Oil For y wat &
being heavyr a Column of a less height
will press as much on M as y Columns
G H press on E F. Hence it may be seen yt a
Lighter Fluid may press on one that is
heavyr

## Propn: 3d

Fig 20

If all the pts F E K of an homo=

=geneous Fluid as ABCD wch lyes and
pla 3 the same Horizontal plain are equally pres-
fig 20 from such a presure there arises no Mocon

For the presure is Equ on all ptes
they all will pres each other with an equ
force Wherefore no one pt will yeild to
another But ye Under Fluid perfectly answ to
by the bottom of ves resists their presur-
downwds Therefore from such a presure there
arises no mocon

Corol Hence also the pts of an
homogenous Fluid are at Rest & not
moved by any Intestine mocon For
since all the parts equally resist, one
part will not yeild to another & therefore
are not moved Contrary to Cartesius's
opinion Who held that Fluidity consisted in
a continuall & various mocon of the parts

Prop 4

Fig 20 If any part as E of the Fluid abcd
is more pressed then the rest It will driv
back ye pts under it & those on every side
pla 3 (a latere) out of their places For if
fig 20 the parts of a Fluid easily yeild to any force

impress^t (by Defin 1^st) It appears that the ptcls F G K nock are next to E will give place to it pressing w^h a greater force from whence E flows into their place Q E D

## Experim^t

Fill a Tube w^th Oil & immerge y^e bottom a little way in a Vess^l of wat^r the top of y^e Tube being kept stopt with y^e finger Soy it stand a good way above y^e surface As at A Then the Watr at A being prest by a high Column will be more strongly prest by y^e inumbt Oil than E & F are by the unnumbt Watr Consequently it will (after y^e finger is remov'd from y^e top of y^e Tube) thrust the watr at E & F out of its place to give y^e Oil liberty to descend & then you'l see the Oil come out pla 3 fig 23 of the Tube in drops & then mixing w^th y^e wat^r it will ascend & swim on y^e Surface

## Prop: 5^th

fig 23 If the parts E of the Fluid A B C be less prest then y^e rest The ptcls near to it as F G K being more prest will thrust it away & possess its roome & the ptcl E will rise in like manner of the parts next to it

be
be equ to its own pressure

For since the pts E bring C.G. pressd
cant resist y^e rest pressing strong It will
yield to them by this D. Law & that always
till it comes to such a place where the pressure
of the parts next to it be equ^ll to its own pressure
where by the 3^d prop it will rest But if it be
a Fluid & it happn that it rests not under
the Superficies It will spread itself all over
the upper Superficies

Corol Hence if the pts of a Fluid
are in Equilibrio they are all equally prest
under the same horizont^ll plains

# Experim^t

Take a Tube & fill it a little way
with Oil & stop it as before The Oil will
still remain in the Tube (being kept
there by the pressure of the air) Immediatly
immerge y^e Tube in Watr (wch may be
tinged with Cochineel for y^e better dis-
=tinction a good way below the surface of y^e
Oil) Then take off y^e finger & you will
immediatly see y^e Watr thrust up the Oil
above the surface The reason is this Sup-
=pose the Oil in y^e Tube only to reach to
c Then the surface of y^e Watr at g being

only prest by the Column of Oil eq
the Water at S & R bring prest with
higher Columns d S, b R the ptrs of the
Fluid at S & R bring more prest than
the ptrs will thrust q out of its place &
make it ascend in the Tube & press up
pla 3 Fig 24 the Oil wch will continually rise till
when it is at a the Oil & water in y Tube
press as much upon q as y Columns d S
b R do upon S R. And because
the Oil is lighter than Water y Column
of Oil wch presses as much on the Surface
q as a column of water would do must
be higher than the Column of water & therefore
the Oil will rise higher than the Surface of
the water to a

Now by this Expm with water
in Oil the Water in the Tube will be below
the Surface of the Oil As at G H So much
as it is specifically heavyer than Oil
we see a Lighter Fluid may press on
and sustain a heavyer

The same will hold if a Solid
press upon y Fluid May even Lead
may thus be made to Swim in the following
manner

Take a Cylindric Glass open at
both ends & ground at bottom Then holding

a smooth wright of Lead close to y^e ground
end of the Glass (with watt or oild Leather
upon the Lead that no wat^r may get into
the glass betwixt it & y^e Lead) plunge y^e whole &
in water till the depth of the Lead in the wat
be about 12 times its thickness or something
more & y^e water will keep the Lead from
sinking pushing agt it by a force equ to y^e
Excess by which y^e water (wch is by the
Vess^ll hindred from pressing immediatly
under y^e Lead) exceeds the wright of the
Lead But if the Vess^ll be raised till the Lead be
but 9 or 10 times its thickness below the
upper Surface of y^e water the Lead will
leave y^e glass & sinke down moving as it
leaves the glass w^th a force equ^ll to y^e Excess
by wch it exceeds y^e water that it keeps out
from pressing immediately under the Lead
Because a pillar of water of the Diam^r
of y^e Lead ought to be almost 12 times its
thickness to be equ^ll to it in wright Thus
will any Mettall be made to swim If
they are sunke into y^e water something
deeper then as many their thicknesses as
they are specifically heavyer then water
Always supposing the Glass to hinder the
water from coming in to sinke above them

As for Example Brass Copp.e & Gold
Antimony Iron will Swim if plunged
above 8, 9, 18, 4 & 7 times their thickness
Because they are about 8, 9, 18, 4 & 7 times
specifically heavyer than Water

## Prop: 6th

pla 3
fig 21

Let ABCD be a Pr.ll of such a
Fig.r as that its Basis cd be for thou
its uppr Superficies AB stay'd a Fluid
contayned in such a V.ssll presses the Bass
CD as much as a prism on y.e Cylind.r
ECDF whose Basis is CD & height FC -
equall to y.e Basis & height of y.e V.ss.ll ABCD
would press it

For since by y.e Corolla of y.e 5th prop all
y.e pts of a Fluid comphended under y.e
same horizont.ll plains are equally prest
& appr.ts of y.e pts at CN & DM are prest
as much as the parts at MV But the
pts at MeV are prest by the prism or
Cylind.r ABe Me V From whence it
appears yt the pts at CN & DM are as
much prest as the prism or Columns -
ECNA, FDMB would press y.m Wherefore
CD is prest as much as it would be if the

Fluid E C D F lay upon it
Coroll. Hence since Weight is a
pressure it manifestly appears y^t the Base
C D sustains y^e same weight wch it would
if prest by E C D F. Which (tho it seems
a Paradox) the Exp^m^t confirms

pla 4
fig 1

Let aBCD be a Cylind$^{r}$ E
exactly fitted with a moveable Basis
so exactly contrived that no Water may
run out Between it & y$^{e}$ side of y$^{e}$ Cylind$^{r}$
L$^{t}$ F be a long Brass Tube continued
to y$^{e}$ top of the Cylind$^{r}$ Let a Rope that is fixd
at one end of y$^{e}$ Ballance & runs thro
y$^{e}$ Tube be fixed to y$^{e}$ middle of y$^{e}$ Basis at
a — And then pouring Water in at F
so as to fill the Cylinder at A D Sow
wright in y$^{e}$ Scale K will be reguird to
move or raise y$^{e}$ Basis E prest by a Column
of water aBCD — as for Example

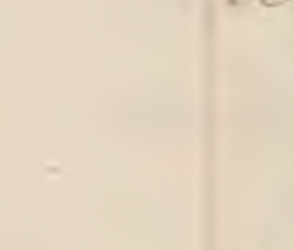
pla 4
fig 1

Suppose 10$^{ti}$ after this fully$^{d}$ Tube
with Water up to y$^{e}$ top weh if it be 3 times
long$^{r}$ y$^{n}$ y$^{e}$ Cylinder you will find that there
wch will be wood of 3 times more wright
to raise the Basis than w$^{h}$ it was prest by
only the Column of wat$^{r}$ aBCD Whereas
it was then raised by 10$^{ti}$ it will not now
be raisd by less than 40 weh will be y$^{e}$
weight of a Column of wat whose Basis
is equ$^{ll}$ to y$^{e}$ Basis BC & whose weight
is equ$^{tt}$ to that of y$^{e}$ Tube & Cylind$^{r}$ viz$^{t}$
G B. C H

Horse hair is reckond to bear
Body that comes nearest ye Specifick
gravity of Water

## Prop: 7th

If in a Fluid as ABCD be laid
downe a Body E having a Specifick
Gravity equall to that of ye Fluid the
Body will be all covered in the Fluid &
will retain any given position



for if any pte of it as E should
remain above the Superficies of ye Fluid
that pte of ye Fluid next K wch is under
the Body E would have greater pressure
then the ptes I & K wch are only pressed
by the Incumbent Fluid for ye immersed pte
of ye Body E presses K of itself as much as
the Fluid in its room would doe Soe the
pte wch is out of ye Water adding to ye pressure
will force ye part K of ye Fluid out of its
place by the 4th prop Wherefore ye Body
E will descend & be all immersed and ye Fluid
as in ye 9th figure When the Body E has an

fig 4
fig 9

Intense Gravity &c wthy of the
Fluid Both thos pts in ∂r Bd & thos in ∂r y Fluid in y same Hori=
=zontall plan are equally prest so yt
by the 3d prop there ariss no Mocon
from such a pressure & since the same
reason holds good in every portion of
y Body E It is manifest that it
retains any one yt is given it 2 ED

Fig 9

## Prop: 8th

In a Fluid as ABCD be immers'd
any Body as E specifically heavyr y
the Fluid the Body will descend to y
bottom but with a force &c to the excess
by wch the Gravity of the Body exceeds
pla 4 y gravity of so much of y Fluid as is
fig 9 &c equal in Bulk for if the Body & y
Fluid were both of y same Specifick
gravity the body would not descend by
the 7th prop But when it is heavyr y n y
Fluid the pts H under the body are prest

strong then those under the Fluid Wh.ch=
force by the Excess of y.e pressure the pts
H will be thrust out of y.e place Wh.ch for.
by the same excess E will d.scend Q E D

Corol.s: A Body immersd in a Fluid
loos.s as much of its gravity as is the
weight of a porcon of the Fluid equall
for in bulk For Gravity is a force
wch pushes a body downw.ds Now since
a Body descends with that force only by
wch it exceeds the gravity of an equall
Bulk of y.e Fluid It appears y.t it Gravitat.s
in Watr with this force alon.

Q

Experim.t

Weigh a piece of Lead in y.e Air
& suppose 12 ℔.s & afterw.ds weigh it in y.e
Watr & find how much it looses of its
wright Suppose 1 ounces Observe also
how high the Lead raises y.e watr when
put into it Then take out y.e Lead & put
in 1 Ounces of watr & you will find y.t
y.e watr added will rise as high in the
Vess.ll as y.e Lead raisd it before And

therefore ye wright that a Body looses
in ye water is just equall to ye wright of as
much water as is equall to ye Body in bulk
What wright ye Body looses the water gets
For example Suppose a Gall of water
wright 10 lb If we hang a 12 wright in that
Gall by a String soyt it may touch neither
Bottom nor sides The Gall of water will
weigh 10 pounds 13 ounces wch is just ye
wright that ye Lead of 12 lb looses & what
the Lead looses ye water gains

Corol 2d Two Bodies wch
are of differt Specifick Gravity as Gold
& Silver aequiponderous in Aer or rather
in Vacuo being immers'd in a Fluid That
pla 4 wch is of ye 1st Specifick Gravity will
fig 3 Exponderate

For Since every Body immerst
in Water looses of its gravity as much as in
the gravity of a pcon of the Fluid equall to it
in Bulk It appears y that wch takes up
the least room (that is) That wch is Spe=
cifically heavyer looses less of its Gravity &
so Exponderats

# Experim$^{t}$

Take a Crown piece of Silver &
a piece of Lead of y$^{e}$ same wright wh.$^{n}$
they are weighd in y$^{e}$ Air afterwards
weigh them in y$^{e}$ Water & y$^{e}$ Lead will
ꝓponderate

Corol$^{d}$ 3. Bodies are easyer
lifted up in Water than in Air

Cor: 4.$^{th}$ Hence the wright of
any Fluid is easily found viz$^{t}$ By immersing
a Cubicall foot of Lead into it & its diff.$^{ce}$
betwen its wright in the Fluid & its wright
in Vacuo is y$^{e}$ wright of the Fluid

## Prop. 9.$^{th}$

Fig 3 pla 4 — If in a Fluid as ABCD the Body E
Specifically lighter y$^{n}$ the Fluid be immers'd
It will not be covrd Only so much of
it as is equall to a peice of the Fluid wch
is as heavy as y$^{e}$ whole Body

For if the whole should be immers'd it
appears y$^{t}$ y$^{e}$ ptes of the Fluid under it

are loss prest by the thos. under the same
horizont & plain are by the Incumbent
Fluid Because the gravity of the Body
E is less then the gravity of equ^ll Bulk of
the Fluid Wherfore by the 5^th prop the ptes
and E will rise till they come to such
a place as where the presure of Fluid A
I K D is but equ^ll to y^e presure of the Body
E (that is) When the presure of the Body
E is equ^ll to y^e presure of as much of y^e
Fluid as would be put in the place of the
Submersed part

COR: 1^st Hence we see the
Specifick Gravity^s of Bodies are recip=
procally as y^e Bulk^s of Aequiponderous
ones By the 4^th prop the immersed pts of the
Body E will be to y^e whole, as y^e Specifick
Gravity of y^e Body to y^e Specifick^ll gravity
of the Fluid

COR: 2^d Therefore the gravity
of Bodies put in a Fluid is twofold Viz.
True & absolute The other Relative
& apparent By y^e first sort of Gravity
the pts of the fluids & of Solid Bodies

Gravitate in their places & therefore
the wrights being joyned they compound
a wright of y^e whole by Relative gravity
Bodies dos not gravitate in thos places
That is, they don't p^ponderate one another
but hindring each others endeavo to descend
they remain in thos places as if they were
not heavy Those things we are in
the Air & don't p^ponderate the Comon poopl.
don't think heavy But thos: wch doo
p^ponderate they dos soon heavy Bcaus:
they are not sustayned by y^e weight of y^e Air
Comon wrights are nothing els: but the
Excess of true wrights above the wright
of the Air From whence also thos: things
are comonly called Light wch are less
heavy & by yelding to the p^ponderous air
mount upw^ds They are Comparativ:ly
light not truly so Bcaus: they do descend
in Vacuo

Thus also in Water Bodys wch
descend or ascend by reason of y^r greater
or less Gravity are apparently & Comparatively
heavy or light & their Relative Gravity

or lightness is the Excess or Defect
by wch their true wrights exceed the
Gravity of watr or are exceeded by it

pla 4
figs 4 & 5 =

## Or The unlike pts of Un=
equall Bodies of the same Specifick=
Gravity in a Fluid heavyer then y^e fluid
are to each other as their whole

## The like pts of Equall Bodies
having differ Specifick gravities are to
each other as their Specifick Gravities

## Experim^t 6

Take a piece of wood & weigh it
Then sink it in a Vessell as far as it will
go with its own gravity & Observe
how high it rises the watr in the Vessell
Having taken out the wood pour as much
watr in the vessell as is equall to y^e weight
of y^e Wood & this will rise up to y^e same
Surface that y^e watr did before when the
Wood was in

S. 1948&5

# Prop: 2-10

Fig 4

The same Body E being immersed in different Fluids howsoever yt its immersed pts will be Reciprocally as the Specifick gravities of the Fluids. For yt immersed pt of the Body E in yt Fluid ABCD is to yt whole by the 1st Cor: do prop 8 as the specifick Gravity of the Body to yt specifick gravity of the Fluid & yt whole is to yt immersed pt in the Fluid, a BCD as the Specifick gravity of the Fluid to yt Specifick gravity of the Body W herefore by 2d: 3: 5 of Euclide the immersed pt in aBCD will be to the pt in a BCD as Y gravity of the Fluid aBCD to Y gravity of the Fluid ABCD. Q E D

Fig 5

pla 2 fig 20

Hence appears a Method of finding out Whether any Grains of Salt are conveyed in Water by the assistance of an Instrum^t made of Glass represented in the Fig^r And Salt water is heavyer than fresh. Find first how deep this Instrum^t sinks in fresh water &

of in trying of his Water it is his mirth
his certain that Salt is contayned in it
as bring heavyer And by how much the
less it is in deth By so much the more
the Salt is in the Water

## The Excellency of Liquo as Wine

for instance is found out by ye same
Gunnum For by how much the Lighter
such Liquors are they are commonly
found so much the Better But their
Gravity is found out after ye same manner

## Prop: 11th

### To find w^t Relacon ye Specifick

Gravity of a Fluid & a Body given im=
= mersed in it have to each other In the
first place Suppose the Body to be Speci=
fically heavyer y^n the Fluid & let its
weight be found in Vacuo & then put
it in the Fluid As y^e weight of the Body
will be to the Excess (by wch the same
Body weighd out of the Fluid exceeds
its own weight in y^e Fluid) So y^e Spe=
= cifick Gravity of y^e Body will be to the
Specifick Gravity of the Fluid For the
Specifick Gravity of Bodys equal in Bulk

are as their wrights But the wright of
a portion of the Fluid equall in bulk
to y^e Body it is by the 1^st Cor of the 6^th
prop is that difference of y^e wrights —
Therfore they being given the relacon
betw^t the Specifick Gravity of the Body
and the Fluid will be given also Q E D

pla 2
fig 18 But if the Body sunck be specifically
lighter y^n the fluid the specifick gravity
of y^e Fluid will be to y^e Specifick of the
Body As y^e whole Body to the sunck part
of by the 1^st Cor. of the 6^th prop

Prop: 12

Two Solid Bodies as A & B being
given to find w^t relacon their Specifick
Gravities bear to each other Let the
Relacon of the Specifick gravity A to y^e
specifick gravity of the Fluid D be found
by the fotm^e prop & Let y^e relacon of the
Specifick Gravity of the Fluid D to y^e
specifick Gravity of the Solid B be
found also From whence by the 20:5 of
Euclid the relacon of the specifick Gra-
=vity of y^e Solid A to y^t of y^e Solid B will be given

pla 4
fig 6

# Prop: 13th

If upon the Fluid ABCD another Fluid as EADF be poured Spe-
= cifically lighter than the form It will be
inverse in the Fluid & it will press it
Superficies by its Gravity

For since the Fluid ABCD
is Specifically heavyer y^n Fluid EADF
Its force of tending downw^d will not be
exceeded by the force of the Fluid EADF
Wherefore the Fluid EADF cannot descend
below ABCD yet since it is heavy it
is manifest it presses the Superficies ad
with its Gravity

Cor: 1st Hence the Pressure
of any Fluid poured in, supposing it to be
Homogeneous & of y^e same density
every where is always according to its hight

Cor: 2d By how much
Specifically heavy the Fluid is by so much
the greater is its pressure

Cor: 3d The Superfcies of any
fluid is prest by air

Fig 7

## Prop: 14th

If the Superficies of the Fluid ABCD
be prest by an Incumbt Fluid But the
part freed from the prisure (wch may
be don by the Assistance of a Tube as
l m n o the Fluid G will rise above the
Superficies A m D n & that to such a
height as that the Superficies m n may
be prest with as great a force as A m &
D n That is, it will raise up to p: 9

For since the part G of the fluid
is less prest yn the rest It will rise by
the 5th prop & that untill it m n be prest
with as great a force as A m & n D and
the same Horizont plain

Cor 1st Hence the fluid n m p q
which ascends has as much Gravity
as the Quantity m n r s of the Fluid E F A D
would have of ye same height as E A & F D

Cor: 2d Thorfor the Specifie Gravity of Fluids are reciprocally to each other as yr Bulk of the Ascended Fluid pressing to yr Bulk pressing Or whose those two Bodies have equal Bases reciprocally as their heights

Scho: Since Air presses the Superficies of all Fluids by its gravity by the 3d Cor of 13th prop If any pt should be from the pressure It is manifest from yt foregoing prop yt yr Fluid will ascend above that Superficies wch is not pressd with Air Untill it press the Superficies under it with as much force as yr rest of the Superficies is pressd by the Incumbent Air And this prop is of very great use in Hydrostaticks For by its assistance all the phenomena of Nature wch are to be attributed to yr Abhorrence of the Vacuum are easily explaind & Vast many things are drawn from it for yr necessary uses of life as Syringes, pipes & other such like Machines But before we treat

of these things it will not be amiss to
speak a few things of the Torricelli^n
Expm^t & to show the Cause of it from
w^ch has been above demonstrated

# Expm^t

Take a Vess^l of Water & immerse a Tube
(open at both ends) into it Then pour Oil
upon y^e water to y^e height of 4 or 5 inches
wch will raise the water in y^e Tube So
high that it may press as much on the
Surface of the Water und^r it as y^e Oil does
on y^e rest of the Surface Let the same
Expm^t be tryed with ☿ & water Vide
prop 4 & 5

pla 2
fig: 19

# Take a Drinking Glass.

& thrust so much y^e water that it may be filled
w^th water the Air being turned out If the
Glass be raised perpendicularly the water
will ascend it above y^e Surface of the
Stagn^t water as at B

The air does not only Gravitate
upon y^e Surface of Fluids But also
upon all Solid Bodies As may be proved

from the Cohasion of 2 flat pieces
of Glass or Marble exactly polisht &
ground together That this depends upon
the pressure of the Air is plainly Evinced
by trying the Experim^t in the Recipient of
an Air pump For after an Exsuccion
or two of Air the Marbles drop asunder

Another argum^t for the p^sure
of the Air may be taken from the Recipi=
= ents sticking to y^e plate upon wch they
are fixd so closely that after 2 or 3 ex=
=succions it requires a considable wright
to pull it away

## Prop: 15th

pla 4 fig 8

To shew the Torricellian Experim^t
and explain the Cause of it Let AD the
horizont & Superficies of the Quicksilv^r
contayned in the Vess^ll ADC be exposed to
the pressure of the external Air & the Tube
PC stopt at P & open at C be filled with
Quicksilv^r After this turned & inverted
Orifice C under the Superficies of the Quick
= silver contayned in the Vess^ll ADC keep=
= ing its Orifice C stopped with y^e finger

untill it be so inverted that ye Quicksilver
don't run out by turning the Tube &
then unstop it holding it in that posture
Now Experim^t makes manifest that ye
Quicksilver in the Tube (P will not
descend below the height of 27 or 28
inches & if the length of the Tube be
less y^n 27 or 28 inches the Quicksilver
will not descend at all Untill its height
Me be 27 or 28 inches (thereby left
within the Tube P^m n. a vacuum of air
& Quicksilver) where it will remain
The reason of this Experim^t appears —
from the foregoing prop. For since
the Superficies of the Quicksilver A D
is prest by the Supincumb^t air but its
ffro C is frood from y^t pressure It must
needs be y^t the height of the Quicksilver
in y^e Tube P be so great As that the
Superficies E ffro y^e same pressure
from y^e Incumb^t Quicksilver as the rest
of the Quicksilver doth from y^e incumbt
air

## Experim^t

If two inches the Tube thus filled be

water instead of Mercury the Mercury
in y^e Tube will descend & y^e Water will
ascend to y^e top of the Tube by prop 4
So a Be. If we imeline the Tube
tow^ds the HORIZON the Mercury will
rise higher & alw^s keep y^e same gendral
height For in the Inclind posicon
it dos not pres so much upon y^e Subjac
Mercury as on y^e Erect Its Gravity
acting ptly ag^t the Sides of y^e Tube
To prove y^t this depends upon the pressure
of y^e Air Take a Glass Tube 4 or 5 foot
long wch has one end (instead of being
sealed Hermetically) tyed ov^r w^th a piece
of Bladd^r Fill it up with water & im-
merse it in Stagnt wat^r You will observe
that wat^r not to descend at all But if w^th
a pin you make a hole in y^e bladder y^e
wat^r will immediatly descend quite out of y^e Tube

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The Tube with Mercury being
put into a long Recev^r, the Mercury
will fall down after the Air is pumpd out

The same Expm^t may be tryed
with Water in the Tube But the Water will

not subside so fast as the Mercury did
and if in the Tube there be left a small Air
Bubble this Bubble will expand it
self and fill the whole Cavity of the
Tube soe much as to depress the Sur-
face of the water in the Tube below the
surface of the Stagnt water

Cor 2 If air were of the
same Density at all distances from
ye Earth its height could easily be found
out For as the difference of the height
of the Quicksilv on the top of a Mountain
is to ye height of the Quicksilv at ye
bottom of the Mountain So ye height
of the mountain is to ye ## height of the
Air

Scholium It is manifest yt a Cylind of
Water of 32 foot Gravitates as much
upon a fluid under it as the Air do's
upon ye other parts of it Therefore Water
can be sustayned at such a height by the
Gravity of the Air

Scholium I have said that

Quicksilo is suspynd at 27 or 28 inchs
For the Gravity of the Air is various &
mutable Sometimes Quicksilo will
remayn 27 inchs Sometimes 28 &
now & thon it will ascend to 29 or 30
inchs From whence it must needs
be That ye Gravity of the Air is chang
proporcionable to its hright

By how much the heavy Air
is, So much ye easyer can it suffer
Vapo raisd by the heat of the Sun For
Vapours are nothing but Watry ptickls
rarefyd by the heat of the Sun and ther-
=fore Thousand ptickls of Watr taking up
a gter Space becomes specifically
lighter then Air From whence off no=
=cessity that ptickle must ascend until
it come to Air Whose specifick gravity
is equall to its own where it must rest
But the Gravity of ye Air decreasing
it must needs be that the Vapo & will dis=
cend Which by the Resistance of the Air
in that region are formd into drops

of water From whence it cannot fall
Rain w^th y^e Gravity of the Air is Increased
But w^n its Gravity is increased the force
is also increased By wch it is able to
suffer as much Vapo^rs & that remayning th^e
Air is clear Hence its y^t such a
Tube filled with Quicksilv^r & inverted wth
y^e Suffices of standing Quicksilv^r is
used to show the gravity of Air & Fair wth
wch follows from it

## Prop 16th

The Elastick Force of Air inclosed
in a Vessell of y^e same Tenour w^th the
Ambient air performs as much
as the burden of the open Incumbent Air

Let there be a Tube or a Vess^ll having
an open Orifice By wch there may be a
Communicacon betw^n the Intern^ll &
y^e Extern^ll air If thou the adjac^t parts
of the Extern^ll air bolge y^n those wch are
within the Vess^ll those will dilate y^mselves
by the 5^th prop Until they come to an^e
force But if the Extern^ll adjac^t ptes (by

the pressure of the Intrinsick Air) are more
pressd y^n thos: within Thos: y^t are without
will be Compressd untill their Elastick
force is Equivalent to y^e force pressing
from without Q E D

This appears from M^r Boyls
Experiment

Cor 1^st From this follows
the reason why we don't feel the weight
of the air

Cor 2^d From hence also
we know why we don't feel the weight
of the Wat^r

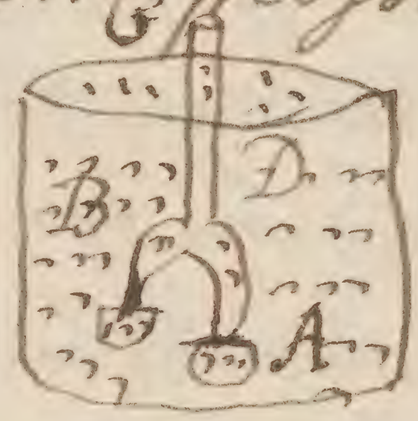
Cor 3^d

pla 4 Fig 13 If a D be a pipe or Curved Tube
open at both ends One of wch as C is immers
in Wat^r or any other Fluid The other as E
being long^r then C from y^e Curve hanging
without the Fluid If there by sucking the
Ligno comes to E untill it runs over It
will continue running Altho you dont
Suck it, till the Ligno in the Vess^ls C

either all drawn out or wants a due height
Q not upon this Condition y^t y^e Orifice L be
lower y^n the Superficies AB of the Liquid
in y^e Pipe For the air being sucked out
of the Pipe into the Thorax the Fluid
under it is forced into the pipe by the pressure
of the Extern incumbent Air By the
pending prop therefore the Fluid will rise
to y^e top D until there is an Aquilibrium
with the pressure of the Extern Air (Suppose
the height FG that is in Quicksilver about
29 inches, in water about 33 foot & so
in other Liquors proportionably according
to their gravity & will run out so soon
as it finds a passage Because the Water
gravitates in the long Pipe & the reason
why DE ought to be long y^e DC is
Because if it were otherwise both C & E
would be pressed equally by the Atmosph
& DE should be shorter Th. Fluid would
be carryed contrary But if D be higher
then F th. Fluid will be forced upwards as far
as F but not further

Take a Tube of this Shape

open at A & C and having im=
=mersed the ends B & C into 2 differ^t small
q.ties of Soils full of water, put y^e whole into a
Cylindrick Jarr or Glass Then pouring
in Oil Turpentine up to D above
the Bent part of the Tube & y^e wat^r will
run out of the Vess^l A into the vessel
B wch shews that a Competent prossure
of a lighter Fluid will
make that com^e over by a
Syphon Evn tho the Air —
comes in at C & this shows plainly that
the Tube Vacui has nothing to doe
in this Experim^t & others of the like nature




# Experim^t

plate fig 4

Take a recurv Tube w^th ends
long & y^e the other & pour wat^r in, till it
rises in both to height A Afterwards put
your finger on the Orifice A & pour in
Wat^r at B till it rise to the top Then put
your finger upon B & leave the Orifice
open & y^e Water will not run out of a

But if you take of ye finger the liquor will
run out at A till it has Subsided in the
Leg B & down to ye Level of the Cistern
at C

Mercury will use the
same way But not to the same height
Since it will rise no higher than it doe
in the Barroscope That is, 14 times
lighter than Water Being 14 times heavyer
For Mercury rises but to 30 Inches —
Water to about 33 foot If the Romans
had known the pressure of Air could —
raise Water to such a height they might
not have been at ye trouble of cutting
through Mountains to make their Aque=
=ducts Level

Scholium Ye Instrument
philosophically explained
this by the abhorrence of a Vacuum
In this place of which now disorderly —
succeeds the Equilibrium of the Air. Gallileus
first thought of it & Torricellius main=
tained & proved it

pla 4
fig 12

The 4th Sort of Pump is made of a good thick long piece of Timber cut cylindrically within & is imerse in the W.H. The upp. pt of wch standing above the Surfaces of the water Which water is not to be sup= =posd free from the pssure of the Air but exposd to it (for otherwise the Water will not be thrust upwds) & in some pt of ye Hollow of the pump there is fixt a piece of Wood a Cross In ye middle of wch there is a hole D Thro wch the water ascends & over this hole is a Valve or at E so placd a cross as to open or shutt according to its being prssd from above or below Also a Bucket at FG let down from above by the Rod or handle (so fitted to the sides of the hollow Cylinder as that the Air can have no passage betw) wch also hath a hole in ye middle of its bottom & a Valve G fitted to it as had DE

Things being thus ordered Water by working the Handle the Bucket is drawn up the Air being upon it & by that means there will be a less pssure of Air upon the water below the Bucket the Water of the Well being prsst by the Ambient Air will be forced up into the

Hollow of the pump thro' hold D (opening
the Valve E) as fast as the bottom of the
Bucket (provided it be not high up in the
top of the Equilibrium) as being free from
any pressure from above & thrust up from
below But on the contrary by turning
the Handle the other way the Bucket is
prest down presses the water immediatly
under it wch ascends thro GD. By this
depression E is shut up & G opnd, thro
wch the water having gott above the
Bucket is drawn up with the Bucket
When it is drawn back (the Valve G being
shut) & finding passage flows out at H
Then water rising thro D succeeds as
before in the place of y^e Bucket that
is drawn up & so continually

## Experim^t 1

Let a Bubble filled with Air of the
same tenour with the Outward Air be Hermetically sealed Then at a flame of a
Lamp heat it & y^e Air being expanded
by heat will burst the Bubble

## Prop: 17

### Concerning the Elasticity of the Air & some Effects depending upon it

The Elastick force of the Air is that by wch a Compressed Quantity of Air endeavours to expand itself into a greater space And since the Air at the Superficies of the Earth is much pressed by a great weight of the incumbent Air It must needs be yt will endeavour to recede from the pressure every way & rush into whatever space it finds free from pressure Whereby its Elastick force it will expand itself equally & uniformly possess all the parts of that space

Of any Elastick Body be com= pressed by a Superincumbent weight it will en= deavour to expand itself equally on all sides by its Elastick force & so equally push the weight upwards by Table by wch it is sustayned downw But if instead of the weight be put any thing yt may resist yt Restitutive Force of that Body Then the Elastick Body will endeavour to expand itself after the same manner wch it did at first & so will push yt Table by wch it is sustayned with yt same force also as at first As also the thing wch resists it Tho in Vain See the Worm spring in the figure By how much yt more

pla 6 fig 16

an Elastick Body is expanded that
resists all any Compression By soe much
the less will its Restitive force be &
soe on the Contrary And yrefore yt force
is alwys equivalt to yr pow yt compriss
it Therefore the Density of the Air
is alwys as yr force pressing it So yt since
the Air within is retayned in its Drish
by yr weight of yr incumbt Air, If
a double weight be applyd it will becom
twice as thick & be compressd into halfe
yr space If it be compressd with thrice
the force it will be forced into 3 times
less space So likewise If halfe of
yr incumbt air be taken away the Com=
=prest air will expand itselfe into twice
yr Space it had whilst compressd &c
Hence since Air contind within
the Walls of an house is of the same
Density with the Externe Air with wch
it communicats It will endeavo to
Relax itselfe equally wth yr Extern
Air & will press the Superficies of Fluids
with yr same force As if those Fluids were
immediatly Exposd to yr whole incumbt Air

And ye fore arr wch will a horse will keep Quick=silver at ye same hight in ye Torricellian Tube as if it was exposd to ye weight of ye whole incumbt aur - Nay some ltle of ye aur of the same density wth the extern aur shut up in a Vessell wth Stagnant Quicksilo will by its Elastick force keep the Quicksilo in the Tube at ye same hight as before

## Experim

pla 2 fig 19

Take a drinking Glass as A and immerge it in Watr soy tho aur may not get out of it. If you sink it all undr watr the Cavity will not be filld, The aur within hindring the Ascent of ye Watr, Which may may be shewn by putting paper into the Bottom of ye Glass, wch will not be wett But if you set the papr on fire the aur by heat being soone expelld the Watr will rise a good way in ye glass. Upon this - prple Diving Bells are made by wch Divers descend to ye bottom of the Sea and breath freely undr watr Yet the further the Bell is sunk the more the

Air will be Compress'd When it is about 33 foot under water tho Air will be compress'd to half y^e Space w^ch it was before This sometimes breaks thos Blood Vessells & makes thom blood at mouth Nose & Eyes

+ A Receiver open at one End will do as well

Fix a Mortar + & bind a piece of Leather on the mouth of it Then take a Cupping glass & having rarefyed the Air by heat Immediatly fix it on the Leather to wch it will adhere very strongly & the Leather will swell within y^e glass Becaus the Air in y^e Mortar has more force y^n that wch is rarefy'd within the glass & therefore presses y^e Leather outw^d. The glass sticks to y^e Leath^r Becaus the Extern^l Air presses it down

Upon this prple Cupping also is explaind The internall Air in the Blood rarifyes when the pressure of the extern^l air is taken away & distends the Skin & makes it swell in the glass This is a proof that there is a great deal of Air in the Blood

pla 4 fig 14

## Prop: 18th

To shew that y^e Ascent of Fluids in Tubes after Suction arises

from the pressure of the Air

When a man by the Muscles of the Breast enlarges the Cavity of the Thorax then the extornall Air finding roow wherein to expand itself rushes in at his mouth into his Lungs So y^t if

pla6 fig 15

one Orifice of a Tube be in his mouth & y^e other immers'd in wat^r From that ptc of the Superficies of y^e Watr wch is under the Tube is free from presure & since the other ptes of y^e Superficies of y^e watr are prest by the incumb^t wight of the extornall air It must needs be (by the 5th prop) that y^e watr will ascend up the Tube Viz^t That y^e ptes und the Tube may be equally prest by the incumb^t watr as much as the rest of the Superficies of y^e Watr is prest by the incumb^t air For the presure of the Extrinsecall air upon the Superficies of the rest of the Watr is y^e Cause y^t y^e Watr ascends up y^e Tube

## Experim^t

Take a glass w^th a narrow neck but w^thout a bottom put a Tube in its neck, Cement them, Then Try a Lamb

Bladder to the end of the Tube within y^e^
glass & a larg^e^ Ox bladd^r^ over the open
end of the glass Soy^t^ y^e^ Bladd^r^ may be
pla 6 fig 11 forced in w^ds^ & drawn outw^ds^ When the Ox
bladd^r^ is forc'd inwards you will obser^ve^
all y^e^ Air within the Lambs bladd^r^ where^in^
the Tube is inserted will be expelled. If
you draw y^e^ Ox bladd^r^ outw^ds^ the Air will
rush again into the Lambs bladder.
After this manner Respiracon is per-
formed The air in y^e^ Cavity of the Thorax
acts on y^e^ Lungs just as y^e^ Air in y^e^ Ox
bladd^r^ does on y^t^ of y^e^ Lambs. If the open
end of the Tube be immersed in Water & y^e^
Ox bladd^r^ drawn back the Water shall
ascend in the Tube & fill the Lambs bladd^r^
Vid^e^ prop 19

## Prop: 19th

The ascent of water in a Syringe
arises from the pressure of the Exter-
nal Air When the Tube of the Syring:
is immersed in a Vessell of water & y^e^ Pis-
ton being brought to R S is lifted up
of Air by the gravity of y^e^ external

Air prsung upon the Suffcios o & p, O
& P will make y^e^ watr ascend in the Tub
as high as R S Viz^t^ that y^e^ pb of the Suffcios
of the Stagnant Watr at q may be
presd by the incumb^t^ Watr in q Sy=
=ringe with y^e^ same force as the Suffcios
o, p is presd by the incumb^t^ Atr

## A Descripcon of the Air Pump
of the M^r^ Boyle made use of, As it is
now altred & improvd

I shall not give a descripcon of
this pumpe as it was when M^r^ Boyle
made use of it Because it may be found
in y^e^ first Dr Harris's Lexicon Tech=
=nicum under y^e^ Word Air pump

pla 5 fig 1 The 1^st^ figure repsents y^e^ pump with all
its Apparatus D D is the Handle w^ch^ turning
with the Nut B B raises or deprises a
Rack A A fastned to the Embolus w^ch^
raises & falls in the Cylindor yt is in the
Body of the pumpe & cant boe seen in
this figure but is represented by third fig^r^
as it is w^n^ taken out of y^e^ Frame
C is a plate of iron screwed down with
Screws upon the upp pte of the pump

with a Notch in it for the Back pt of
y^e Rack to slide up & down in It is also
represented in Fig^re 2^d . G F I is the Re-
ceiver open at both ends G G is a smooth
brass plate layd on y^e Receiver with a wett
Leather to keep out the Exterior Air
H is a Brass Collar w^ch Cork & oyld Leather
to let the Wire K I be drawn up & down
without admitting the Air. M N My
y^e brass plate of the Air pump on w^ch the
Receiver stands with a wett Leather betwt
the plate & Receiver L L is a Board an inch
& a halfe thick supported by the Iron
prop P w^ch is raisd at right angles with the
side of the pump a b to support the plate
& Receiver when the pump is made use off
Otherwise it hangs down by means off
the hinges a & b

V F is a brass pipe w^ch lyes in a Groove made
in y^e Board having a Communicacon w^th the
Cylinder towds F & with y^e plate Receiver &
Mercuriall Gage at V

R is a Cock to let y^e Air into y^e exhausted
Receiver at pleasure w^ch will run in from
V to N & so put up the little wast pipe into
the Receiver

O is a Glass V.ss with ♀ in to receive
y^e end of y^e glass Tube or Gage NO This
Gage has a graduated piece of Box to
show how high ♀ rises & consequently the
Ricew is exhausted

S is a Board w^ch supports y^e V.ss. O. K K
are 2 Iron screws to screw the pump to the
floor of a Room w^n the Eccent requires the
Equee to be very Steady They are also
represented in Fig 8 - E is a Cock to let out
the water w^ch must be kept at AB above
the Cylinder when you use the pump

Fig 3 represents a Brass Cylind close at y^e
bottom for y^e piston represented by Fig 4
to move up & down in This Cylind^r is screwed
down to the Stool of the pump bring Litt
down into the Box and AB & there is a
Cement made of pitch & Brick dust pound
hot into y^e Box about the Outside of the
Cylinder w^ch growing hard w^n cold keeps
it fixed

F is a hole to receive y^e Screw of the pipe
XY of Fig 7

Figure 4 represents the Rack A & Cuboius
BB wch make up the piston of the pump

gg Is a brass plate fixt to y^e Rack about
¼ of an inch less in Diamet^r then the

inner Diamt of the Cylinder

ee ff Represent 3 or 4 round peces of Shirtpr
Leather oild & very soft abt ½ an inch more
in Diamt yn the Bore of the Cylind ch
being put on imediatly below the platt gg
with folds round yd said plate upto w A
When y piston is lett down into the Cylind

c d is a stiff piec of thin Sole leath whos
Diamt is so nearly Equ to y of the Cy=
=lind Bre that it must but just slip down
into y Cylind without friction

B B is a brass plate screwd on at y bottom
of the Rack to keep y whole Emboliis tog th

When this piston is let down into the
Cylind below the hole I the Air betw F &
easily passes upwds by the side of the Emboliis
forcing the soft Leathr up roundly plate
gg But when you draw it from the bottom
no Air can gett downe below y Emboliis
Because the spac betw the sides of the
Cylind & y plate c d is not large enough
to let y Air fold downwds So y the grater the
prosure of the air & of y Water (which alws
lyes on y Emboliis) is, the more this soft Leath
is prosd to y sides of the Cylinder & shuts fou
the passage downwds round the Emboliis must

bo clos: stopt & kept on y^e Air Enclo
y^e Bore of the Cylind^r & should not be truly
round as it happens in this Which by
long use was become a little Ovall

Figure 7 is a true exact Repsentacon
of the pipe V F of Figure 1

Y X is that pte wch is to screw into
the Cylind^r having a square place at A
to receive the Key of fig 5 wch serves to
turn all the Screws with its end s: or its end T:

Z c a b Is that parte of the pipe wch lyes und^r
the plate that is screwd on at Z

c Is to screw on to the pte Y at C in fig^e 1

a Is a Screw to receive the Gage at the place
marked V in fig 1 It must have a Valve
of with Blade at y^e end of the Screw b to wch
the Cock R is to be screwd by applying the Key
Q to y^e Square place mar b

Figure 6 is the Brass platt $\frac{1}{4}$ of an inch
thick wch is truly flatt having a brass Rim
round it to keep the Water from spilling
when it is made use off in any Experim^t

P is a hole in the platt with a Screw
to receive the little pipe y^t stands upright
under the Recrv

V is y^e platt wch is the Bottom upw^d

showing the Screw that fits the hole
Z of the pipe of fig 3 at y^e place marked
N in fig 1

The Receiver is exhausted
in the following manner When by
means of y^e Handle or Winch D D y^e
Embolus is raisd above y^e Level of
the pipe V T in fig 1 (that is above
y^e hole T of the Cylind^r in fig 3) there
a Vacuity in y^e Cylind^r under the Embolus
H & in the pipe T L So y^t the Valve at T
being no longer prest, the Air in the
Rec^r & easily lifts it up & by its Elasticity
expands itself So as to fill y^e voyd Cylind^r
Then depressing y^e Embolus the Air
comes up out of the Cylind^r betw^n its
sides & y^e Embolus & so comes bubling
out thro y^e Water at A B & raising the
piston a 2^d time y^e Air in the Rec^r
(tho pretty much rarefyd already)
lifts up y^e Valve at E & runs into the
Cylind^r with ease to fill the voyd
space under the Embolus & then is
exprest out as before & soon till the

Recr is quite exhausted Which
may be known by the rising of ☿ in
the Gage For when it is gott up to ye same
hight as that at wch it stands in the
Barom[r] the Recr is exhausted
Because the pressure of ye Air being wholly
taken off from y[e] pte of the Surface of ☿
wch is directly under the Tube the exter=
=nall Air will press upon y[e] other part of
the Surface of the Stagn ☿ & so raise the ☿
in the Tube till it make an Aquilibrium
with the weight of the Atmosphere
NB Tho the externall air can come into
the pipe I it cannot gett into y[e] exhaust
Recr Because the Valve is shut the closer
tow[ds] N M the more Air presses upon it
being made only to open tow[ds] L

to

# Experim of the Air-pump

1/ Lay your hand on y[e] mouth of a small
Recr & by the pump draw out the Air
& ye hand will swell within y[e] Recr
After a few Suctions the Air will press
your hand So y[t] you cannot raise it

2

Tye a Bladder to ye mouth of a Receiver & exhaust ye Air from the extern air will depress the Bladder so much yt a mans strength will not be able to sustain it

3.

Invert a Receivr & tye a weight to ye neck of a Bladdr over ye mouth of the Receivr & hanging on ye Outside of it Having drawn the Air out of the Receivr the Outwd Air will press so on the Bladdr as to thrust it up into the Recvr & raise the weight

4

Take a piece of Glass & put it on the mouth of a Recvr, having drawn out ye Air The weight of the incumbt Air — pressing on ye glass will break it. By this Expint we prove yt ye Air presses every way For in wt position soever the Glass be It will still be broken by the incumbt Air.

This is also provd by the strong Cohasion of 2 flat pices of glass or Marble exactly polisht & grounded together As also by a Glass Recvint stocking so close to ye plate after the Exsuccon of the Air that it requires a considerable weight to put it away

5

In the Torricellian Expint If the Tube wth ye Mercury be put into a —

into a Long Recev the Mercury will fall
down at y^e Exsuccion of the Air

6 If the same Expm may be reyd w^th water
in the Tube But it is to be obsrvd that y^e
Water will not subsid So fast as the Mercury

7 If in the Tube there be left a small
Bubble The Bubble will expand its Self
& fill the whole Capacity of the Tube
Even so much as to depress the Surface of
the Water in the Cube under the Surface
of the Stagnt water

8 A Flaxd Bladder after the p^sure
of y^e extrnall Air is taken off dilates its Self
as far as it can

9 The Expansion of the Air in a
Bladder will raise a wright after the Ex=
=tern^ll Air is taken away

10 A Bladder in w^ch wrights are put to
sink it under water will rise with its
wright after the Extraccon of y^e extern^ll Air

11 A piece of Corke to w^ch is tyd just
so much wright as to make it sink
all under water Except the uppr Surface
of it After the Air is extracted will rise

higher But when you let y' air in again
it will immediatly sink towds y' bottom

12 Fishes in y' water in y' Recipient
will rise to y' top of the water When the
air is drawn out

13 A Glass Bubble in wch is left just
so much water as will sink it after the
extraction of the extern air will rise

14 If you draw out y' air from a Square
Glass Bottle the wright of the incumbt air
will break it to pieces

15 If you put such a Bottle so closely stopt
that none of the air can get out of it into.
the Receiver after you have drawn out
the external Air That wch is in the Bottle
will so dilate itself as to break y' Bottle

16 If you put 2 Brass Hemispheres
together shutting them one wthin another
& only putting a piece of wet leather
betwixt them If after this you pump out
all the air & by the help of a Valve at y'
bottom of one of the hemisphores The air
cant return into them They will stick
so closely by reason of the Extern air that
it will require a very great force to pull
asunder

17/ If you put any Animal into y^e Recev^r & pump out y^e air the Animal will immediatly dye

18/ If you take a Glass Bottle half full of wat^r having a glass Tube cemented in y^e neck of it One end wch is below the Surface of the water & y^e other being above y^e top of the Bottle has a brass top w^th small holes in it If you put this into the Recev^r & pump out the air The air in the Bottle will dilate itself So as to press on the Sur= =face of the Wat^r & raise it up in Spouts thro the holes of y^e Tube like a fountain

19/ If you put a Bell so cased on a wooden Frame y^t it may have room to move into a Recev^r & pump the air out Then if you shake the Pump So as to move the Bell you will scarcely hear y^e sound of it This is a proof y^t Sounds depend upon y^e Air

20/ If you put a glass of Warm water into the Recev^r & pump out the air The water will presently seem to boyle The reason is this Viz^t the Elasteck force of the air wch is in y^e water being incread by heat & not being prest by any External air It endeavo^rs to dilate itself & by that

means makes the wat bubble up This
is the way by wch the Air may be almost
all extracted from ye wate

# How to Condense the Air

pla 4 fig. 10

So that you may put what Quantity you
please into a Vessell

If you have a brass Vessell suppos-
half full of water with a hole on y top of it
Into wch you may screw a little brass-
pipe at A with a Cock at B. By wch you
may let in y Air. If on this you screw a
Syringe wch has at y bottom a Valve by
wch the Air forc'd into the pipe may be
kept from returning again & likewise
a Curve Tube screwd fast at C or only a
small hole & a Valve at y same place. If
then you draw up the Sucker of the Syringe
the Air will come in thro y Tube D into
the Syringe at C And y Valve will then hinder
it from returning If then you open the

Cock at B & thrust down y^e Sucker the Air will likewise descend into the Vessell & by the Valve at y^e bottome of the Syringe be hindred from returning (By repeating this often you may put w^th ease of Air you please into a Vessell. If then you take off the Syringe & Screw on in y^e place of it a Pipe w^th holes When you open y^e Cock the Air pressing hard on y^e water will force it up to a gt height & will spout out in figures according to y^e holes of the pipe

# Of Barometers & Hermonet & Hydrometers

It is Evident by what has been already proved that y^e Mercury within the Tube gravitates as much on the Surface of the Stagn Mercury as y^e air does on the rest of its Surface & that a Column of Air reaching to y^e top of y^e Atmosphere

is of the same wright with a Column of Mercury of the same Basis & of an hight equall to y^e Mercury in y^e Tube Now if the Air should grow heavyer & prss more on the Surface of the Stagn^t Mercury Then the Mercury in the Tube must rise higher that it may be eqvll in wright to a Column of Air of the same Basis, reaching to the top of the Atmosphere

Hence it follows that the hight of the Mercury in the Tube may be fitly applyd to measure the Gravity of the Air & on that acct an Instrum fitted to y^t purpos is called a Barom^tr

Sometimes Mercury rises 30 inches Sometimes it stands at 29 Sometimes at 28 Sometimes it will sink to 27 But seldom under & Consequently the gravity of the air must alter proportionably

Since Gravity is always pro=portionable to w^t the Matter weighs Tis impossible that the air should change its Gravity without changing its Quantity of matter And y^e first Some have thought this different of the Airs Gravity to proceed from its being more or less overcharged

with Vapo & If this wre ye Cause there must
be as many Vapo in the Air at a time as
are equll to 3 inchs of Mrcury For so
much we find the Mrcury rises or falls

Now Mrcury is about 14 times
heavyer yn water & consequently there must be
in the Air at once as many Vapo as will
equall in Length a Column of Water of 42
Inches high & whos Basis is equ to the Sur=
face of the Earth Which is more than falls
down in raine during a whole yar For a
whole yr raine dos not fill a Vess above 14
or 15 Inch. high As is observed in the history
of the Royall Society at paris

The reason then Why the Air is heavy &
at one time then another arises from there
being more Air in that pt of the Earths Surface
where ye Air grows heavyer & this proceeds
from Winds (Viz) If the Wind (wch is
nothing but a Stream of Air) should blow
over any place & ye Air there moved should
be kept in that place by Mountains or hills
Or if 2 contrary winds should blow on the
same place the Air will be heapd up in
the middle & consequently there being more
Air its Gravity will be increased But if
the Wind should blow over a Country
the Air wch is over that place will be les

ingrity & consequtly lighter Hence it
plain that Winds are the only Cause of
the Airs Gravity

When the Air is heavy the Sun
acting on the Surface of the water raises the
Vapo's from it These being raised are Spe=
=cifically lighter then air & consequtly they
must rise higher till they come to an Air
of the same Specifick gravity with y^m's lows
where they will rest And a vast Collection
of those Vapo's form Clouds So long as
the Air continues heavy y^e Vapo will be
sustaind & y^e Weather will be fair But if the
Air turns lighter the Vapo wch were in Aqui=
=librio with it before will now Ponderate &
consequtly descend In their descent being
continually checkt by the gr^t resistance
of the Air with wch they meet) they will
be condensed This Condensation will still
grow more & more till at last they are
formed into drops of rain Hence it follow
that when the Mercury in y^e Tube is higher
then the Weather will be fair & when fally
low The vapo^s then (not being sufficiently
sustaynd by the Air) must fall & the
Weather will be Rainy & the Rain more or
less according as y^e Mercury rises or falls
in the Tube

pla 2
fig 21

Upon this principle common Weather
glasses are made But to make the Change of
the Airs gravity more visible several

Instruments have been contrived

i st

## The Wheel Barometer which consists

of a Recurvo Tube A B C G E filled with
Mercury The gravity of the Air pressing on
the Surface there sustains a Leaden Ball
tyed to a String at y^e other end of w^ch there
is also tyed a wright by String runs on
a pulley at C to wch there is a Hand or Index
applyed wch moves along with the pulley &
a large piece of Brass B F G E divided into
any number of equall parts marked 1:2:3 &c
When Mercury falls at B it must rise at
E & consequently raise the Ball w^ch When upon
the wright at D will descend lower & draw
the String with it And by this motion the
pulley being turned the Hand will shew
the last Variation of the Air

This was invented by Dr Hooke
But this Instrument has one inconvenience
wch makes it almost useless For in damp
Weather the String to w^ch the weights are tyed
is contracted & in dry will grow longer
By this motion it will move y^e Hand
When in y^e mean time y^e Mercury has
neither risen nor fallen

A Watch string will do better then w^ch are now
pla 6 Ball instead of a Leaden one wch would be
fig 18 eaten by the Mercury

2d
1

Fulgas contrivd another Instrm.
after this manner. A B C E F is a
Recurvd Tube so made that the ptes of it
A B & D E have a much gtr Basis than
the rest. The Tube being filld with Mercury
the Gravity of the Air pressing on the Surface
at G will sustain the Mercury to the hight
A B and y parts A B and D E being
of an equal hight If the Mercury fall an
inch at A B it will rise as much at D E
Thro the Orifice M on y Surface D E
is pourd Oil of Tartar p deliquium or
Spirits of Wine or some other Liquor that
will not freeze to y hight F. Now when
the Mercury rises at D E but one inch. It
will raise y liquor wch is pourd in the
Tube K L an inch & y slender Tube M P
being of a much less Basis than the Tube
K L it must rise higher in M P Thus
if the Basis D E be 10 times greater than
the Orifice M P for one inch that y Liquor rises in the Tube
K L it will rise 10 inches in the Slender
Tube M P (i:e:) If Mercury falls
one inch in the Tube A B, the Liquor will
rise 10 inches M P

This Sort of Barometer has also an
inconvenience wch is That as y Weather

is hot or Cold. by Liquo in the Tub MP
will dilat & contract its Ls & consequ
rise or fall Which as the Mercury contains
still y same height

3d

Since Mercury in a Tube keeps
alw[s] the same perpendicl height, however
the Tube be includ, the best Contrivance
for a Barometer seems to be this

A B C is a Tube bended as in the fig
B C is about 26 inches long & A B so includ
that it may be 15 Which as the perpendicl
A E would not be above 5 according to y
pla 6 Structure For every inch y Mercury rises
fig 3 in y Ordinary Tube it will rise 3 in the
Includ one A B

As Barometer show the differ changes
of air as to Gravity & Levity Whence we obtain
Fair & Foul Weather. So Therm. are
made use of to measure the Various
Temperature of the air as to Heat & Cold
To discover wch there are several Instrum 4

contrivd

1 The first is almost in the form
fig 13 of a Barometer only the upper end of the

Tube ends in a large Glass Ball This Ball is heated by putting near the fire soyt the air in it will be rarify'd & soun wd expld by heat Then immediately the neck of the Tube is to be indrgd in Stagnt water which should be tingd th w some Colour that it may more easily be perciud. As the air in the Ball A begins to cool It bcomg more rare & less compressd yn y extrn air y Water in y V. Bll will be impld up into y Tube to B by the force of the Extrn air & so compress y air in A as much as the extrn air is compressd — Now if the air in A be afterwd again more heated it will endeavo to expand itself & fill up a gter Space & so press y wat down But wn it grows cooler it will be contracted into a less Compass & y water will again ascend Soyt wn the water in y Tube descends the air is hotter & wn the watr ascends the air is cooler

plab: 2 fig 1

The second kind of Thermoscope is by a Return Tube thro the Orifice of wch at D the tingd water is poured & fills up the space B C comprising the air in the Globe A

in wch when the Air grows more hott it
expands itself & takes up gretr roome,
by pressing ye water in the Tube upw
to D & w^th ye Air is coold it is again Con=
= dens'd & ye Water falls downe Soy^t the
rising of the denotes heat & its falling
the Coldness of the Air Contrary to
w^t is done in the first Sort

3d
pla 6
fig 12

The Third sort is in this
fashion. Thro ye narrow neck of a
Glass Bottle filled w^th water is put a long
Tube open at both ends the low end of
wch is immerged below the water After ha=
= ving fixt the Tube with Cement Soy^t there
can be Communicacon betw the exter^ll
air & that in ye phial, air is blown
strongly thro ye Tube by wch the air in
the phial is compress'd & ye more will
press ye Water up to D & if the Air alw^s
continue in ye same Pos^n & as to heat
& cold ye water should alw^s continue
in ye same Staton But w^n the Air in the

phial grows hotter It will endeavo to
expand its sfo & prefs more strongly on
the surface of the wator & raise it high
in the Tube

4 In these sort of Thermomt & all others wch have any Communicaon with y^e Ext.rn^ll Air The Liquo^r will not only be depr.ssd or raisd by the change of the Air as to heat or cold but also to any pla 6 alteracon as to Gravity or Levity and fig 5 consequently the Tompature of the air as to heat & cold may remain When more = tholes the height of the wator may be considably altred This sort of Ther = = moscope is not lyable to y^e same inconvoudnce Tis a long Tube with a Glass Ball at y^e end of it wch being filld with high rectifyd Spirits of Wine half full up to D the remaining empty part to C is considably heated That y^e air may be expelld after this the top of the Tube is immediatly to be sealed hermeti = = cally So y^t air may not re enter the Tube Then the Rarefaccon & Condensaton

of the Spirit of Wine by wch it rises or falls
in yᵉ Tube according to the dogr of heat
or cold shows yᵉ Tempature of the Air
as to heat & Cold

5
pla 6
fig 14 =

Another sort of Thermoscope
is thus contrivd. A & B are 2 Cylindri=
call glasses & fills joynd to yᵉ Recurve
Tube D. G. the upp part of the Vessel
A is voyd of air & yᵉ rest is fille with
Mercury as in yᵉ Torricellian Ex=
= perimᵗ & yᵉ Mercury rises halfe way in the
Vessell B. x x x x On the surface of
yᵉ Mercury in B there is put in a Tube
some tinged liquor or rather Oil of Tartar
& Diligently wch will not freez & reaching
up to D to yᵉ end of yᵉ Tube B K a Glass
Globe C full of air is sealed on Hermetically
& to prent Communicacon with yᵉ extern
air In this Thermometr when by
the cold of yᵉ Ambient Air the air in
C is coold & condensd the Mercury will
by its own weight subside in A & rise
higher in B & consequently impell the
liquor up into the Tube B L & of the

Basis of the Cylindre & Vessells A & B
be to the greator y^t the Basis of the
Tube BK Whose Mercury falls one
inch in A orifice one in B the Legior
will rise 10 inches in y^e Tube BK —
Also if the Air be heated in Cane rarefy
it will by expanding it self make the
Mercury descend in B & rise in A So
that y^e smallest Variacons as to heat &
Cold are thus shown by the Ascent and
Descent of the Liquo in the Tube BK

## To Measure y^e Moisture &

pla.^4 fig 11 Dryness of the Air We use an Instrum.^t
call'd a Hygrom.^r of wch there are 2 or 3 sorts

1st

The first is made by a fine Ba=
= lance One of the Scales of w.^ch is put
a piece of Sponge & in y^e other a weight
to counterpoize it. The Sponge in Damp
weather imbibes y^e moisture & becomes
heavyer in dry Weather The moisture

being exalted tho Spring grows Lighter
& so by the mocons of the Examn
we find y^e Alteracons of the air in
respect of its humidity To make
tho Variacons more sensible The Exam^n
of the Ballance is made very long wch
pass on a Circular Arch of Brass
divided into degrees marked 1: 2: 3 &c
& according as y^e End of the Examen
is at any of those degs so wo judge of the
Weather

plab fig 2 Another sort is contrivd after
this manner To a Rope or Cats guts a
Cylindric^ll wright is tyed in Damp
Weather The rope by twisting itself
will contract & pull up the wright & in
fair Weather let it sink further down
To make y^e Variacons more sensible
the Cylindric^ll wright being about 15
or 16 inches round is divided into
30 or 40 equ^a pts marked 1: 2: 3 &c
to prevent its being injured a Glass is
put over it thro wch the String pass

at A. This Class is coverd w^th brown or blew pap Except one small hole, Shew^ch y^e figure on y^e side of y^e weight may be seen Now y^e twisting or untwisting of the Rope according to y^e Variation of y^e moistness of the Air will alw^s point a new Fig^r to y^e hole

3
pl: 1: fig: 17

C Third sort of Hygromt^e is made w^th y^e Board of a Hats Cat or y^e husk of a small Vetch w^ch in dry weather twists & in wet weather untwists One end is fastned to y^e bottom of a Box, y^e other comes thro a hole in y^e Lid & has an Index adapted to it So y^t the motion of y^e hand or Index on the top of the Box shows y^e variation of y^e Moistness & Dryness of y^e Weather

plat
fig 3

# Catoptricks

## Definicons

1 Rays of Light are thos: wch are
diffusd every way in Streight Lins thro ye
same Medium & spread ye selves con=
=stantly after ye same Rno as long as
they continue in ye same Medm

2 A Radiant is that from whos:
points Rays dispose themselves every way

3 Diverging Rays are thos: wch
meet in a point opposite to ye direcon
of their mocon Or thos: Rays wch spread
themselves after yt manr as if they had all
come from one point Whither they really
come from yt point or not

As the Rays BD going from B to D
are said to diverge from the point C
Whither they actually come from it or
not For tho they should come from A

they are said to Diverge from C Because if you produce yᵉ from B till they meet in a point Opposite to yᵉ direction of their incon That point will be C

4 Converging Rays are those which meet or produced meet in a point towards that part Whither the direction of their incon tends

As the Rays DB are said to Converge towards C Whither they meet in Cor after Reflection thro yᵉ Glass EE they go on parallel to yᵉ Line aCD

5 The Focus is yᵉ point where the Rays meet

6 Parall Rays are those which come from a point at a grt distance from its Contrary but a very small Angle one to another as from yᵉ Sun

7 Rays are said to Reflect when they are Sent backward in the same Medium

a Reall Focus is yᵉ place where the Rays actually meet as in Fig 5 B where the Rays D meet after they have past

the Glass CC & ye point A (where those converging Rays would meet if there was no Glas at CC) is calld the Imaginary Focus

fig 8

In a concave Mirro & ye Object E will be the Focus of the Rays wch having diverged from E obj^t & fallen upon y^e Concave Mirro are by reflection made to converge at E

A Concave Glass transmitting light has no real ffocus of all the rays B. comes after they have passed the glass they diverge from each other As y^e Rays A after they have passed y^e glass E diverge towards D But y^e point C is calld the Vertuall Focus of that Contrary glass

fig 3

8 / The Angle of Incidence is that wch is contayned under the Incident Ray & y^e Appendicular to y^e plane at y^e point of Incidence as ABC

9 / The Angle of Reflection is that wch is contained under the reflected

Ray & y^e perpendicl^r as y^e Angl^s DBC
Forthwith's ABE & DBF are calld the
Angles of Incidence & Reflexion

## Theorem The Angle of Incidence
is alw^s equall to y^e of the Reflexion Wch
is confirmd by experience & has been
found all ways demonstrated by Mathema-
ticians

10

## Speculla or Mirro
are thos: wch by reflecting of the Light form Images
of extern^ll Radiants

## Theorem Rays comming
pla: 7 from a point A & falling on a plain
fig: 104 Mirro BC after reflection diverge from
the point a wch is in the ppendicl^r As far
behind the glass as y^e Radiant is before it

For becaus^e aB is equall to aB & DB is com-
=mon to y^e Triangl^s aBD & aBD & y^e
Angles at B are Equall, tho Angles aDB &
aDB will be equall by 1 Euclid prop 4
But by 15 of this same tho Angle aDB
& GDC are equall Therefore if AD be the
Incid^t Ray, GD will be y^e Reflected after
y^e same manner it may be shewn That

H I is ye reflected Ray of the Incid A I
& K F of a F & therefore all ye reflected
Rays if produced will meet at a

plate 7 fig 4

If the Eye were placed at H it would receive the Rays wch come from a & are reflected at ye Surface B C as if they had really come from a & consequently the Eye will be ye same way affected as if it were at O & rice ye Rays coming from a & therefore the Eye at H will see the Image of ye point A at a

Fig 6

All the Image of every point is as far behind ye glass as ye point is before ye glass the Image must be ye same way inclined to ye Glass as ye Radiant is for ye Image of the point A must be at a & the Image of the point E must be at e

Hence it follows yt if the Glass lyes horizontally O & its Images inverted & Mon will appear with their heads downw as when we looke in ye Watr

What has been shewn of the prple Radiants is also true of their

Images For they may be consid:d as
Obj:ts wch send Rays & ye fore If there be
another Glass to receive those Rays there
pla 7 will be another Image formd within that
fig 7 glass & so yt Image will have another Image
& From whence arises ye Multiplicacon
of Images by the help of 2 or 3 plain Looking
glasses

Suppose 2 Lookingglasses BC
EF Let the Radiant be A whose Image
by the Glass BC is a This Image being Con=
=sid:d as a Radiant will send Rays to ye glass
EF at a & this Image will likewise have
Image in ye glass BC at G & so you may
multiply Images as far as you please If
fig 7 GD HE, KF be incid Rays there reflected
4 Rays will be D.A, E.A, F.A (i:e) If Rays
be Converging to ye point a there to
form an Image & there be interpose a
plain Speculum BC they will reflect to
the point A & form an Image there Exprim:
answ to this exactly

pla 7 Take a comon Reading or Burning
fig 9 Glass E & put ye Radiant at A i:e the plan

of the Image to be found be a puta
Lookinglass at B C & a Maus eye at O —
will see ye Image at a my Air betw
him & ye glass For by the Burning Glass
ye Rays coming from a point in the
Radiant A are made to converge to
correspond point in ye Image a But
by the Lookinglass they are intercepted
& Reflected Therefore they will be
turned another way & those ey went fro
one point at A will meet with anoth
correspond to it a Where they will form
an Image

In concave Spherical Mirro
the Image of any point is alw in a Line
passing thro ye point & ye Centre

Thus the Image of the point E will be
at e The Image of f at f & of G at g

Hence it follows yt if the Image
fig 10 be in y Air before, it will appear Inverted

The reason why the Image is found
is Because all ye Rays wch come from
the point E & falling near the Vertex

of the Mirror reflect for they will
meet at e Whence they do forming
at e the Image of the point E after the
same manner those wch come from F.
after Reflection met again at f & there
form y Image of F

If the Radiant approaches y Glass
the Image will recede from y glass & at
y Cent. of the Sphere they will both meet
If y Radiant approaches still nearer the
Image will go out beyond y Centre
& w the Radiant comes to be at y distance
of one 4th of the Diamt from y Vertex
y Image will be cut at an Infinite distance
When y Radiant comes near to the glass
then 1/4 of the Diamt y Image appears —
behind the glass & Erected If the Mirro
be Convex the Image of an extern Radiant
is alw behind y glass

## The Magnitude of the —

pla 7
fo 8

Image may be known from this That it
always appears under y same Angle fro
the Vertex of the Speculum that

Radiant dos & consiqtly they will have
the proporcon one to another that their
distances from the Vortex have And
therfore if the Radiant bi further off
then y^e distance from y^e Glass it will
be bigger y^n the Image. If at y^e same
distance at y^e Centre they are equall
If the Image is further off then y^e Radia^t
from the glass it will appear bigger y^n the
Radiant See y^e figure where E may be
the Radiant & e the Image Or e-the ff
Radiant & E the Image

N^a B^e: Th- Focus or point where
the Image is formd is y^e middle point
betw the Vertex & Centr of the Sperules
In all thos Cases where y^e Radiant y
is supposd at an infinite distance As the
Sun & y^e Rays sent from it reckond as
parall^ll

# Dioptricks

pla 7
fig 12

When a Ray of Light comes out of one Medium into another it chang: its Direcon This changing of th. Direcon is what we call Refracon

The Angle of R. fracon is com= =prehended under y^e refracted Ray & a per= =pendic^r drawn to y^e Surface of the refracting Medium at y^e point where the Incid^t Ray falls on y^e same Medium as the Angl. HDK. If the Ray of light goes into a thicker Medium it comes nearer to a ppendic^r. If into a thinner then it recedes from y^e ppendic^r

Fig 11

There are several ways to shew thy by experience

V: G: Take a Bason into which put a piece of money at A & then recede so far back that y^e sides of the Bason may

intercept y^e light so y^t light cannot
come in a straight Line from A to y^e
eye at D If water be affrw^d pour'd in
the mundy will be seen for y^e Ray AB
when it comes to y^e Surface of the Air
at B changeth its direccon & goes off
in DB & so enters the eye

Fig 12

Suppose y^e Medium E C to be
Air H K Glass or water & AB y^e Surface
of the Medium H K Let E D be a Ray of
light entring y^e Medium at D As the Angle
E D C is the angle of Incidence So
is H D K the refracted angle. The Lines
of those Angles have alw^s a certain
determinate proporcon to one another &
if you take small Angles they very Lines
are alw^s in this proporcon If E C be air
& H K glass, the Angle E D C is to H D K
as 3 to 2. If E C be air & H K water
the proporcon betw the Angles E D C & H D K
is as 4 to 3

Fig 13

To shew Refraccon more plainly
Take a comon Burning Glass & cover it

with paper in wch let there be 2 Holes
thro wch the Light is to pass at B & C —
Then put a Candle at A If the Light
passe thro without Bending, The Rays
comming thro y^e holes B & C ought to —
diverge further & further from one another
But to find y^t if the Light be bent on
a piece of paper the Rays Converge
one to another When the paper is at I, the
light falls at G K. When tis removed further
the Rays fall at D E nearer one another
& when the paper is removed to F there be 2
Lights Coincide & then diverge again

pla: 8
fig: 4

Suppose G K water & I A F air
the Rays comming out of water into air
are refracted So y^t those wch come from
the point E soon after Refraction as if
they had come from C & entr y^e Eye at
I A as if they had all come from y^t point
So y^t C E is $\frac{1}{4}$ of B I.

Hence w^n we look on an Object
in water It appears nearer y^e Surface
than it is & consequently Art an Oar

in the Water will appear Bent For the point
fig 3 A will appear higher viz at B & y^e point
C at D For y^e Ray falling from
of Bring seen in the posicon F C I will
be seen in that of F D B

pla 10
fig 6 If the Object A be seen thro the
PRism G H by y^e Eye at D It will app^r E
as if it was at C For y^e Rays falling from
A, Obliquely upon the Surface of the
prism at I are refracted tow^ds the ⊥ (Be-
= cause they goe from Air into glass) and
would goe on still in y^e direccon G K
If they continued to move in glass But
emerging at G out of Glass into Air they
are Refracted from the ⊥ & going on in
the Line D G into y^e Eye as if they came
directly from C

If the same Obj^t be seen thro a
Medium wch is terminated by many
plain diff^t Surfaces It will appear to be
multiplyed into as many as there are
Surfaces For thro every Surface the Obj^t
is seen in a diff^t place & consequently as
many Surfaces as there are so many

distinct Objects will appear Th: Rays
wch com: from th: Obj^ts thro thos:
differ^t Surfaces of the glass forming th:
Images thereon on differ^nt parts of th:
Retina

A Lens is a glass w^ch y^
formin^ated by 2 Spharicall Or on:
plain & ond Sphoric Surfac: And it y
Convex on both sids or Convix on
one side & flatt on th: othir

Concave on both sidds or concav:
on one Side & flatt on y^ othr

Or a Menisus That is Contrav:
on one side & Convex on y^ othir

pla 10
fig: 5

When Rays divorge from any
point of an Obj^t & spread yms: two ^my
way If you expose a Convix Lens to thos:
Rays they will form a Cone whos:
Vortex is at the point of Divergence &
Bas: at y^ Lens As y^ Rays wch divrg^
from A & fall on y^ Glass CD Whin
thes: Rays pass thro the Glass they are
all refracted (Except that wch falls
at E on y^ middle of the glass) & meeting

again at y^e^ point B form another Cone
whose Base is y^e^ Glass CD (on y^e^ other
side) & Vertex at B. This Cone together
with y^e^ other Cone is calld a Pencill
of Rays & A E B is the Axis of that
pencill or a Line drawn from the point
of Divergence on one side of the glass
to y^e^ point of Divergence on y^e^ other
There are as many pencills of Rays
thro a Glass as there are visible points
in the Object & tho the Axis of tho Oblique
pencills suffer some refraction in passing
Obliquely thro y^e^ Lens yet thou are not
to be took upon as refractive Because
after they are passd the glass they got on
in a Line // to y^e^ line in wch they moved
before they Entrid it & the thinner the
Glass is y^e^ more insensible is that
Refraction

pla 8
fig i

Let a B represent 3 pencills of Rays
passing thro a double Convex Glass & from
the Object ABC by means of a double
Convex glass, has its Image project at
c b a. The Angles wch the Axis of those
pencills y^t^ come from the extremity's

of the Obj^t make with the middle of the
glass determine y^e magnitude of that
Image & the place where the Pencills of
Rays terminate on those Axis is called
the Distinct Base Because there only
is y^e most Distinct Image of the Obj^t
projected

By the former Expim^t was
shown y^t y^e Light wch come from a
certain point in y^e Candle placed
at a due distance from y^e Glass or
Lens was made by Refraccon to
converge & meet at a point Therefore
if there an Object placed before the
Glass at A B C, all Rays wch com-
from y^e point A will after Refraccon
be made to converge at y^e point a
& all y^e Rays wch came from B will
after refraccon meet at b & all the
Rays wch come from C will be refracted
to c And if the Eye be at a it will receive
the Rays diverging from y^e point a be
y^e same way as if it had rec^d y^e Rays
directly coming from y^e prple Radiant
A B C & therefore the Image will be found

at a b c & inverted If a piece of pap^r
be placed at a b c the Rays will thence
be reflected by the paper & will point
on the pap^r the Image of the Radiant

Pla 7
fig 1

The Image & y^e Radiant have
alw^s the same propc^on y^e one to y^e other
that their distance from y^e Lens has
& y^r fore if the Image be further from the
Lens then y^e Radiant is It will be bigger
then y^e Radiant, If nearer it will be
less. If the Radiant at A B C be brought
nearer to y^e Lens the Image will retire
further from it & it may be brought
to such a determinate distance as to
cast the Image as farr from the Glass as
may be require to magnify it to any
given propc^on If the Glass be equally Con=
=vex on both sides & y^e Radiant placed at
a Semidiametors distance from the
Lens the Image is cast out at an Infinite
distance & if the Radcaut be placed at an
infinite distance the Image is at a Semi=
= diametors distance from the Lens

If the Sun & the Radcant w^ch is at
an infinite distance & y^e Glass be suffi=
ciently broad In y^e place of the Image there will
be a Flame w^ch will burn very intensly

Becaus all y^e Rays w^ch come directly
from y^e Sun & fall on y^e broad Lens
are by refraccon brought into a small
space to form y^e Imago.

pla 8
fig 6

If at y^e place of the Lens Imagi-
wch is somtimes calld the FOCUS of
all^le Rays or somtimes simply the
Focus) there be placd a Lucid Body
as a Candle or Lamp the Rays after
refraccon thro y^e Lens will goe out
parallel & not divorge from one anothr
& y^e Light not spreading will continue
in y^e same Intensenss at all distans
& consequtly it will illuminate Objts
at a distance On this prple Convex-
Lanthornes are made

If the Radiant be near the
Lens then the Focus of parall^le Rays the
will not be seen on y^e other side of
the Lens But on y^e same side that
y^e Radiant is, onely further of & not
Inverted but Erect

pla 8
fig 5

Suppose aBC a Radiant
near to the Lens then the Focus of
parall^ll Rays all y^e Rays wch come

from y^e^ point A will enter the Eye
at E As if they had come from y^e^ point
a & all y^e^ Rays w^ch^ come from B & C
will seem to have diverg'd at first from
b & c So y^e^ Eye will see y^e^ Obj^t^ not at
ABC but at a b c & because the Angle
DED is y^e^ same w^ch^ a E c the Obj^t^ will
be seen Magnify'd. a b c being gtr.
Fig 6 then ABC

If a Room be darkned & only one
hole made in y^e^ Window to let in the
Rays wch come from Extern Objects
& in y^e^ hole there be placed a Convex
Lens This Lens will form the Images
of its External Objects that are before
it & if at a distance there be put a piece
of white pap^r^ the Image will be recd
on it & they will appear inverted The
reason of w^ch^ follows plainly from the
former prple For all the Rays wch come
from any one point of the Obj^t^ will
by refraction be made to meet at one
point on y^e^ pap^r^ & there they will be
reflected again And y^e^ same thing is
true of every other point So y^t^ the Image

of ovry point thus put togothor on y^e^ L
pap^r^ will show y^e^ Image of the Radia
Ob^t^ in y^e^ same Colour y^e^ Ob^t^ is off
Bocaus ovry Image is formd by the very
same Rays & of the very same affecton
as to Colour as they wch come from
the Ob^ts^ are The Ob^ts^ being nigh
further from y^e^ Lens the Images
are, those must be much less And y^e^
nearer the Ob^t^ is to y^e^ Lens the Image
will be further from it & appear the bigg^r^

If the Ob^t^ move, the Image will
also seem to move provid it do not
move directly tow^ds^ the Lens. By this
prple the prospect of places may be taken

pla 7
fig 14

The appearances of the Magic
Lanthorn differ but little from those
of y^e^ Dark Chamber The Lanthorn has
2 Convex Glasses at A & BB & a Lamp
burning at C. C is a Slitt made to hold
a long piece of wood DC in wch are
cutt rounds holes to hold the
pictures wch are of painted Glass & y^e^
Flame of the Candle or Lamp C being great

a Considable qtity of Light falls on the
pictures & passing thro the Lens will
form y^e Images of those pictures on the
opposite Wall

The pictures being much wider
to y^e Lens than the Images on y^e Wall
the Images will be prodigiously larger
than the pictures according as the Wall
is distant. If by pulling out y^e Tube in
wch the Lens B is fixd you make the
distance from y^e pictures greater, The distance
of the Images will be less & consequently
the Images themselves will be less in
proportion

## A Concave Lens forms

pla 8 fig 13 the Image on y^e same side y^t y^e Rada^l
is But much less & nearer it

For if the Obj^t B A be put before
the Lens F F it will be seen by the Eye
at C in y^e position a B & by consequence
less than y^e Obj^t For y^e Ray a E falling
on y^e Lens at E is refracted into g E &
comes nearer to y^e perpendicl & y^e Ray
F g coming on y^e Convex Surface of
the Air at g will be refracted into g c

and recd. from the perpendicl Soy
y^e Ray G St will entry^e Eye at Cor^e ay
if it had come directly from a & not
from A Soy^t the Eye being at C and
receiving the Rays coming from
a & B will by y^e same way affected as
if they came from a A for y^e same
reason the Rays wch come from
B will enter y^e Eye at C as if they had
come from b Soy^t the Eye will see
the Obj^t BA at b a ward to it and
also much less y^n it really is

pla 8
Fig 8

The Eye is a Lens contrived
by God to project the Images of extern
Objts on y^e Retina & thou it is, that
we see distinctly When those Images
are distinctly painted on the Retina

Immediatly under the first Coat of the
Eye wch is call^d Tunica Cornea
A B, there's a Humour of the same
Consistence with water & is call^d the
Aqueous humo^r E F In the middle
of this there Swims another Membran
call^d the Uvea C D wch is opaque &
lets no Light pass thro it But is perforated

at CD & y^e^ small hole is calld the pupilla
So yt all the Light that forms y^e^ Image
must pass thro that hole. Next to y^e^ Watry
humo is a Consistent Globe wch
is calld the Christallin humo^r^ K & bi-
= hind this is place the Vitreous humo.
GH wch is not consistent as the Christall^ine^
But yet is firmer yn the Aqueous. Behind
the Vitreous humo lys the Retina
wch ariss from the Insertion of the
Optick nerve at L, & it is supposd to
consist of an infinite numbr of small
Nrvds standing perpendicularly on y^e^ Concave
Surface of the Eye on wch the Images of
extern Obj^ts^ are painted

The figure of the Eye is Spharic
boing the only figure wch can turnd every
way in y^e^ hole it fills up

NOW becaus those Rays only
wch come from any single point of an
Obj^t^ & fall on y^e^ middle of the Eye at M
are united at one point on the Retina
viz. wch fall at A & B obliquely not
being exactly united with the rest, at
that point. Therefore the Eye is furnisht

with the Uvea an Opake Coat wch
intercepts all those Rays wch fall
obliquely on ye Eye

The Pupilla or hole in this Coat has
power to dilate or contract itself to let
more or less light pass thro it And in the
day time it is but small For too much
Light from the Sun would hurt ye Eye
In ye night time it grows wider to let
in all the light it can to affect the
Retina & this is the reason Why at
Twilight things appear bigger than
they are For ye Pupill being very wide
a great many Rays come on the Retina
wch fall on the Cornea very obliqly
& therefore will not all be united in
one point of the Retina But take some
space on it & So ye Image of the whole
will be much greater yn it ought to be

Tis on ye same acct that a Candle
in the night time seen at a distance
appears much greater than it ought to do
And ye same is true of the Fixd Stars
For they appear much less if we looke
at them thro a small hole in a Paper

To make all this plain Take
2 Tin Tubes made to go one within the
other So yt you may make y^m longer or
shorter as you please If at one end of this
Tubes was put a Lens & at y^e other fastned
a piece of Oild pap^r or any thin Membrane
of an Animal to repsent the Retina &
the end where the Lens is put be covred
with a Lid in wch must be made a
small hole to repsent y^e pupilla Then
if you draw y^e Retina backw^ds or forwards
you will at a certain distance see the
Images of extern Obj^ts painted on it in
their true colours As in the Dark
chamber or Magick Lanthorn.

Since then the Eye is a Lens
wch projects the Images of externall
Obj^ts on the Retina. If the Eye should
keep alw^s the same Figure & the Retina
y^e same distance behind it There would
be but one certain & determinate distance
at wch it would see Obj^ts distinctly.
N.B. If the Retina were just at y^e
distance of y^e Focus of all Rays from
y^e Cornea No Obj^t would have their
Images distinctly projected on the Retina

But those wch are at a good distance
from it, So long as the Eye kept that
Figure. But if the Eyes were off such
a Figure, as to cast y^e Images of wch
Objts on the Retina If the Objts were
further removed the Images would not
fall on y^e Retina But betw the Cornea
& it If the Eye kept on & y^e same
Figure alw^s There would be no distinct
Vision But when Objts are at our
Determinate distance from the Eye;
wch would be very inconvenient for
Animals, and therefore to remedy
this the Eye has a pow^r of changing the
Figure Whereby the Cornea is sometimes
part of the Surface of a Larger Sphere
Sometimes of a lesser And tis on this
acct That y^e Eye is made to consist of
various & flexible humo^rs & parts The
most moveable of all wch is the Watry
humo^r lying immediately under the Cornea
Next to wch is the Christalline of the
firmest Consistence. The Christalline is
closely embraced by the Ligamentu
Ciliare by wch it is Suspended & the
Fibers of the Ligam^t by their Contraction

or Dilatacon bring y^e Christallino
backw^d or forw^d When the Christallino is
brought forw^ds it forces On to^ds the Aqueous
humour & makes the Eye more pro=
= tuber^t or the Segment of a Lesser Sphere
On y^e contrary when the Christallino y^e
brought back the Aqueous humo^r returns
also & y^e Eye becomes more Flatt or the
Segm^t of a larger Sphere Soyl by the Mocon
of the Christallino the CORNEA is made
pla 8 more or less Convex Thi^s gives Reason
fig 10 how made on the Cornea This by this
Mobility or changeablines^s of the Eye that
we are made to see Obj^ts at different
distances from us

If the Obj^ts are at a distance the Eye
that looks on y^m grows Flatter. If they
are ndar us the Eye grows more Convex
Now if the Eye could apply itself to see
Obj^ts at a distance from us We could alw^s
see every Obj^t distinctly & ndar Obj^ts would
be brought so ndar the Eye that we could
see them Magnifyed in any propor^n we
plased For we estimate the Magnitude
of Obj^ts seen with one Eye by the Angle und^r
wch they appear Thus the Obj^t AB appring
under the Angle A E B its Image takes

up the Space a b on yᵉ Retina But the Obᵗ D appearing only under the Angle a E D its Image takes up only the space c D on the Retina

Fig 11

One and the same Obᵗ at differᵗ distances from yᵉ Retina will appear under very differᵗ Angles Suppose a B the Obᵗ & yᵉ Eye at O Tho Angle under wch the Obᵗ appears is yᵉ Angle a O B If yᵉ same Obᵗ be removed to a b the Angle under wch it appears is the Angle a O b If it be brought to a b the Angle at yᵉ Eye is a O b So yᵗ the Angle will still be greater the nearer the Obᵗ comes to yᵉ Eye

pla 8
fig: 14

Suppose then a small Obᵗ a B, wch at yᵉ ordinary distance, at wch the Eye sees, appeares under yᵉ Angle a E B. wch is so very small that the Eye cant perceive the pts of yᵉ Obᵗ distinctly If then the Eye were brought to or 100 times nearer (V: G) to D & if it could form itself to see distinctly at all distances It would appear to yᵉ Eye under the Angle

A D B tm or 100 tunes bigg^r^ thon A C B
& consequtly the Obj^t^ will appear 10 or
100 tunes magnifyd But thon tho y^e^
Eye consisting of Floxible ptes can chang^e^
its figure So as to see at sovrall distans
Yet this Mutability of fig^r^ consists within
certain Limits & thos must be certain
distances in wch an Obj^t^ must be putt
to be seen distinctly So yt if the Obj^t^ be
put nearer to the Ey^e^ than this determi=
=nat distance It can never be seen distinctly,
The Image not falling on y^e^ Retina but
its place would either be behind the
Retina if y^e^ Rays could goe so far
before they were intercepted, Or y^e^ Image
will be Vertic^ll^ & before y^e^ Eye. If the
Obj^t^ were nearer yn tho Foci us of all
Rays & consequtly it cant be painted on
the Retina

If there were any Solid Bodies
swiming in the Aqueous humo^r^ those
can never have their Images on the
Retina But their Images will be
Vertic^ll^ & before y^e^ Eye This is a

Demonstracon that ye Muscæ Volitantes can nevr be prodvcd by Obts swiming in ye Aqveous hvmo as phisitians gen:ally imagine

pla 8
fig 17

Since then the Obt AB may be so ndar to ye Eye at D that will be wont ye limits of distinct Vision It is plain that it cant be seen Magnify.d to ye naked Eye in any given proporcon Which it would be cond the Eye see so distinctly at all distances But if before the Eye D be put a Lens CE wch consists of Segms of small Sphores & ye distance from ye Obt of the Lens be less then the Focus of all Rays the Lens will form the Image of the Obt AB at ab (that is) all ye Rays wch come from the points A & B will enter the Eye as if they had come from the points a & b & ye Eye will see ye Obt at ab at the distance necessary for distinct Vision & it will appear vnder the Angle aDb or aDB Which is ye very same that it would have been vnder to the naked Eye

at D. If the Obt were placed at thi flowy
of pall Rays thou all tho Rays wch
come from yt point A after Refraction
thro y Lens would go pallel & onto thi Eye
as if they had come from an infinite
distance So yt Eye would see yt point A
in tho Line A d produced in Infinitu

pla 8
fig 16

The same thing is true of tho point
B & yt Obt would be seen at an infinite
distance under yt Angle a D B wch is
tho very same Under wch it would be
seen by the naked Eye if it could see
it at D distinctly Suppose an Obt
A B wch to the Eye at C tho ordinary distance
for distinct Vision appears under the
small Angle A C B If thou Desirest to see
this Obt 100 times magnifyed Take
a small Lens whose Focus distance
for pall Rays is 100 times less yn A C
or B C & put yt Lens at D So yt yt distance
of the Lens from the Obt may be 100 times
less yn the distance of the Eye at C from
the Obt If thou bring my Eye to D to
the Lens I shall see the Obt thro yt Lens
under yt Angle A D B wch is 100 times
greater yn A C B & yt Eye will see the

Obj^t thus magnifyed distinctly Because
it sees it at grt distance from the Eye
For most mens Eyes are framed to see
Obj^ts at a good distance from y^e Eye dis=
tinctly

pla 8
fig 15 If there were an Obj^t AB
& a Lens E whose Focall distance is F L
that Obj^t would appear by the Lens under
the Angle AEB

If there were a Lens whose Focall
distance is D F the Angle under wch
the Obj^t will appear will be A D B &
then A E B If there were another Lens
at C whose Focall distance is C F the
Angle under wch the Obj^t would appear
thro this Lens is a C B wch is still
greater then a D B

The less the Focall
distance of all the Rays of any Lens is, the
more will magnify the Obj^t & if the
Lens be equally Convex on both Surfaces
the Focall distance for all the Rays is a
Semidiamt distance from the Lens. The
less than the Semidiamt of y^e Sphere is
(of whose Segm^t the Lens is made) the

more it will Magnify ye Obt and ye whole art of magnifying Obts by single Microscopes is to grind Glasses exactly of peces of very small Spheres

Leven Hook & Melon

Phitid to grind Glasses whose Focall distance not much exceed yr 100th part of an inch I have heard of some that are less & if they were litt fall on paper there would be use of another Microscop: to find them with

To know how much any of those sugl: Microscopes magnify: Take a small pore of papr Suppose 1/4 part of an inch Diamtor & paste it on a Wall Then take a Microscope & put any small Obt at yr Focus of yr pall Rays from it Then recede so farr from yr Wall till the pap on it appears of the same bigness with yr Obt seen thro yr Microscope Then consider wt proporcon the distance of yo Eye from the pap on yr Wall bears to the distance of the Obt frm the Microscope & in that proporcon the Obt will be magnifyd or appear gtr then it would do Were it —

plaid at y^e same distance from the Eye
with the pap^r on y^e Wall

We may form this more easily
thus Take a round piece of pap^r of ab^t 2 or
3 inches Diamtr & dye it black w^th inke
then pass it on a pane of glass in y^e window
& recede so far fr^m it Till looking thro the
Microscope with one Eye on y^e Obj^t & w^th
the other on the pap^r you perceive them both
to be of y^e same bigness or y^e one exactly
to cover the other The propcon betw the
pap^r & y^e Obj^t will be exactly at y^e distance
of y^e Obj^t from y^e Microscope to that of
the Eye fr^m the pap^r & consequently When
the Obj^t appears of y^e same bigness w^th
y^e pape it is magnifyed in that propcon

The most nicest Eys have
such a Flexibility & changeableness of
fig^re That they cant only see Obj^ts at a get
distance if they appear und^r any sensible
Angle But also those y^t are within 3: 2:
or 1 foot of their Eye Yet there are stil
whose Limits of distance for distinct Obj^ts
as to their Vision are much less (V: G:)
Some cant see Obj^ts but when they are
very near y^m or close to y^r Eye Which

Mar 8
Fig 9

bring very Convex or y^e^ Sqm^s^ of a small Sphere will unite the Rays of Obj^ts^ at a distance before they come to the Retina

They who have this fault in their Sight are calld Myopes

On the Contrary those are they whose Eys are very Flatt or Sqm^s^ of large Spheres Who cant see Unless the Obj^t^ be at a good distance fr^m^ them & y^e^ Rays wch come from one point & fall on y^e^ Eye are Quam proxime parallell Because old Men have generally y^r^ Eys very flatt Sort they cant see but at a distance Therefore those who are troubled w^th^ this fault are calld presbyta. Both these faults of Vision may be helpt by Lenses For those who are short sighted & cant see any Obj^t^ but w^t^ is very near^ly^ by looking thro a Concave Lens will see distinctly Obj^ts^ wch at y^e^ same distance without the Lens they could not see but very confusedly

Suppose an Obj^t^ ABC & the Eye of a Myops at C tho Obj^t^ being without the limits of distinct Vision will be seen confusedly by the Eye at E But if you put

in the Concave Lens at G betw the
Obj^t & the Eye all y^e Rays wch came
from A will enter the Eye as if they
had come from a wch is much nearr
to y^e Eye & within y^e Limits of distinct
Vision These same may be said of B & C
From this Explan y^t fore tis plain that
by the help of such a Lens y^e Eye of a Myops
will see distinctly the Obj^t ABC The
much less then if it had been seen with
the Lens

pla 8
fig: 12

IS a Concave Lens makes
Short sighted people see more distinctly
So also a CONVEX Lens helps the sight
of presbyta For Suppose AB an Obj^t &
the Eye at C this Obj^t is so near the Eye
y^t it cant be seen distinctly by it Ff-
therefore there be a Convex Lens put at C
So y^t the Obj^t may be within the FOCUS
of all Rays the Eye will see y^e Obj^t
AB at a & b at a further distance & within
y^e Limits of distinct Vision & it will see
the Obj^t take up y^e Space a b wch is greater
than AB & therefore it will see it Magni-
fied Whereas an Obj^t seen thro a Lens

pla 9
fig 1
fitt for a Myops does alw^s appear less

# Double Microscopes

are those wch consist of 2: 3 or 4 Lens's that are designd to magnify ye Obj't

The first Sort is made after this manner. C is a Lens of a small Sphear: before wch the Obj't A B is placd at such a distance yt yr Imago made by the Lens C may be cast out at a gret distance on yr other side Viz at a b So yt if a b be 10 or 100 times further from C yn A B is, it will be 10 or 100 times gter yn A B. D E is another Lens wch is larger & nit so near the Image a b that a b will be either in its Focus of all Rays or somew nearer So yt the Imago of the Image of a b made by the Lens D E may be cast out at a distance fitt for distinct Vision Now if the Eye be applyd at G. it will see the Obj't under an Angle equal to yr Angle E F D & consequently magnifyd & at a distance fitt for distinct Vision

plag
fig 2

Most of the Double Microscopy
now in use have 3 glasses & are made thus

C is yᵉ Obᵗ glass wch is a peᵉ
of a small Sphare. A B is yᵉ Obᵗ
sounds further yᵉ the Focus of Parll
Rays So yᵗ yᵉ Image may be cast out
& fill the space a b tou or 100 times
g for thou A B. D E is another Lens
or Segm of a larger Sphere placed at a
little distance from a b To this joyn
the 3ᵈ glass G H wch is the Segm of a
Sphere sounds lesse yᵉ D E So yᵗ the
distance betw the 2 glasses G H & D E
may be less yᵉ the distance of the Focus
of the Parll Rays of the glass G H & that
the Rays wch come from the Image
a b may pass yᵉ 2 glasses & after refracᵒⁿ
enter the Eye at L. So yᵗ all those Rays
wch came from yᵉ Same point of the
Image a b may enter the Eye as if they
had come from an Infinite distance
(i: e) The 2 glasses G H & D E ought to
be so placed yᵗ yᵉ Rays wch come from
any one point of yᵉ Obᵗ a b may after

Refracton thro these 2 glasses must all[ll]
& so form in y[e] Eye a distinct Image For
it is plainy in this Case tht Eye will see
y[e] Obj[t] magnify'd and distinct By this
Microscope tht Eye can perive a gtr pcon
of the Obj[t] yn by the former Becaus tht
Rays at b & a would fall so obliquely on
the glass DE that without the 3[d] glass
G H they could not ontor y[e] Eye & consi=
=quently without that glass the Eye will
see only the middle part of y[e] Obj[t]

As Microscopes are usd to discov[r]
the small parts of those Bodies we have
near us & wch we can put at a due distance
from y[e] Microscope So Telescopes
are for discerning Bodies distinctly that
are at a great distance from us. So y[t]
tht Rays wch come from any one point
of the Obj[t] & fall on y[e] Obj[t] glass of tht Tele=
=cope may be conceivd as parall & consiqtly
tht y[e] will unite & form y[e] Image at y[e] Focus
of parall[ll] Rays

Pla 4 Fig 15 The First & most Simple
sort of Telescope is the astronomick
for looking at y[e] Stars. CD represents tht
Obj[t] glass wch is a pcon of a very large Sphere

A E and B E are 2 Rays wch comⁿ
from ye extremity of an Objt placd at
a grt distance as ye Objt A B is to be
suppos'd all ye Rays wch comⁿ from
the same point that A E cam from
will after refraction thro the Lens mᵗ
at a & all ye Rays wch came from the
same point of ye Objt with ye Ray B E
will after refraction meet at ye point
b Ergt the Image of the Objt will be placd
at b a at a distance of the Focus pallel
Rays As you may see by the prickt Linꝭ

Suppose G F H a Lens of a
much greater Convexity or a segment of
a much Sphere plac'd so near ye Imag
a b that a b may be in its Focus of pallel
Rays (that is to say) That all the Rays wch
come from the point a & b may after Refracⁿ
run parall and enter the Eye at L As if
they had com from a grt distance This
Lens being thus adapted & put in a Tube
the Eye will see distant Objts distinctly
magnifyd in ye propᵒⁿ that ye Focall
distance of the Glass D is greater than the

For all distance of G H For first the Eye will see the Obj^t distinctly Because y^e Rays wch come from the points a b falling on y^e Eye at L as if they had com from from a great distance will be exactly united in y^e Retina & there form a distinct Imag^e

pla 9 Fig 3

2^dly The Obj^t will be seen much greater y^n without y^e Telescope For y^e Angl: under wch y^e Obj^t is seen without y^e T: Stop is the Angle A L B & y^e Imag^e on the Retina of y^e Eye is A B but y^e Angl: under wch the Obj^t is seen with the T: Stop is y^e Angl^e G L H & y^e Imag^e made then on the Retina is I K & therefore as much as this latter Angle & Imag^e are greater y^n the former So much is the Obj^t magnifyed by y^e Telescope. Again let A & B be

pla 4 fig 15

Rays coming from the end of an Obj^t at an infinite distance whose Imag^e is a b The bigness of wch is determined by the Angle a E b wch those 2 Rays make in passing thro y^e Obj^t glass without any refraction

Because they are the Axis of 2 pencills
of Rays. Let the Focall distance of th.
Obj^t glass be E K & y^e of y^e Eye glass F K
& A E B be the Angle under wch th.
Obj^t is seen without y^e Telescope Now
because th. Imag^e & the Obj^t appear
under y^e same Angle from y^e Lens the
Angle a E b will be equ to y^e Angle
A E B & consequtly to y^e Angle under
wch the Obj^t appears seen without th.
Telescope. But y^e Eye at L sees the
Imag^e a b under an Angle equall to
a F b, & consequtly so much greater
as y^e Angle a F b is than a E b so much
greater will the Obj^t appear when seen
with y^e Telescope than when seen without
it But so much as E K is greater y^n F K
So much is the Angle a F b greater y^n
a E b (i:e) The Obj^t is magnifyd in
proporcon to y^e Focall distance of the Obj^t
glass keeping y^e same Eye glass & consequtly
The longer y^e Focall distance (i:e) the
larger the Sphere is of wch the Lens is a

porcow the more the Obj^t will be
magnifyd & yrefore the whole ffircon
of those sort of Telescopes is to get Obj^t
glasses well ground of a long Focall
distance There are some of those
Telescopes of 150 or 200 foot in bough
but tis very difficult to manage &
turn y^m as one pleases Tis plain that
y^e Image ab is inverted in respect
of the ppl^r Obj^t & consrqtly w^t ever Obj^ts
we looke at w^th this Telescope will
appear Inverted

pla 9 fig 4 = 2^ly Galileus^s Telescope do's like=
wise consist of 2 glasses whereof the Obj^t
glass is convex & a Segm^t of a lesser Sphere
They are fixed in a Tube after this manner
CD is the Obj^t glass whose Focus of all^le
Rays is at a (i:e) The Images of distant
Obj^ts made by the glass CD are at a b So
that K is y^e Focus of all^le Rays to y^e Axis
of the glass So y^t if it were not for the
Interposicon of the Eye glass GH all the

Rays pall$^{el}$ to y$^{e}$ Axis would Converge
to y$^{e}$ point K But then by the interpo-
= sicon of y$^{e}$ Concavo Eye glass G H wch
is placed at such a distance from y$^{e}$ Imag$^{e}$
a b that y$^{e}$ point K is in its Focus-
of pall$^{el}$ Rays or Virtuall Focus
all y$^{e}$ Rays wch before they passd thro
y$^{e}$ glass G H wore converging to y$^{e}$ point
K will after refraccon on y$^{e}$ glass G H
run pall$^{el}$ to y$^{e}$ Axis. The same way all
y$^{e}$ Rays wch before the refraccon on y$^{e}$
glass G H wore Converging to y$^{e}$ point
a b will after refraccon run pall on
pla 7 to another So y$^{t}$ y$^{e}$ Eye when it will
fig 3 receive all y$^{e}$ Rays wch wore going
to a b as if they had all come from
a b placd at a grt distance & y$^{e}$ Ey will
see y$^{e}$ Obj$^{t}$ under y$^{e}$ Angle a F b wch is
equall to a F b Where fore is to be observd
that y$^{e}$ Imag$^{e}$ a b is inverted in respect
of the prpl Obj$^{t}$ Because a b is inverted
in respect of a b. a b will be erected
& soen y$^{e}$ same way that y$^{e}$ prpl Obj$^{t}$
A B is seen

N$^{a}$ B$^{e}$: The Virtuall

Focus of a Concave Glass is that point
from wch the Rays pallil to yᵉ Axis
divrgo after refracon thro yᵉ glass as
yᵉ point C is the Virtuall Focus of pallᵉ
Rays of the glass EE Because the Rays
BD wch come from A & bofore they
entrod yᵉ glass wre pallᵉ to yᵉ Axis AC
are by refracon thro yᵉ sd glass made
to divrgᵉ from the point F as if they
had come really from that point Becaus
yᵉ first Sort of Telescopes show all Objᵗ
inverted & yᵉ 2ᵈ discovers but a small
part of an Objᵗ Therefore a 3ᵈ sort have
been contrivd consisting of 4 glasses
Vizt one largᵉ Objᵗ glass & 3 Eyᵉ glasses
placd after this manner. D is the
Objᵗ glass whose Focus of pallᵉ Rays is
at a b or wch is yᵉ same thing Lot a b
be the Imagᵉ of some distant Objᵗ Therᵉ-
=fore it will be inverted in respect of the
Objᵗ

E F is an Eyᵉ glass a segmᵗ of a
liᵗˢ Sphere placd to ward yᵉ Imagᵉ a b
that Rays wch come from any one
point of it after refracon thro E F

may run pall & so fall on a 3d glass
G H Thos pall Rays falling on y^e^ glass
G H will after refraction convrge to
the Focus of pall'll Rays & form an
Imago a b invrtd in respect of a b &
consequently Rectd in respect of the pcpls
Radiant

I K is another glass placd
so near y^e^ Image a b that y^e^ Rays
coming from any one point of the
Image a b may entr the Eye at I as
if they had come from a point at a
great distance, that is, that they
will after refraction as I K run
pall'll & then the Eye at I will see
the Imago distinctly rectd & mag=
=nifyd! Observe that e B is
y^e^ Comon Focus of pall'll Rays to the
2 glasses C D & E F & a b is the Focus
of pall'll Rays to y^e^ 2 glasses G H &
I K

Finis

# Sr Isaac Newtons Lo.

## Proposicon

## Lights which differ in Collour differ also in degrees of Refrangibility

### Experim.t

If you apply any Flat side of a prism to y.e hole of a Dark Room to receive y.e Rays wch come from the Sun Those Rays wch are different in collour will be seperated by a differt refracon & diverge from one another (as in y.e first Fig.r) & appear distinctly in an Oblong figure on y.e opposite Wall They will be refracted in this order Viz.t The Red rays will be refracted least, The Orang somew.t more, The Yellow more than that, The Green y.t more, The Blue more yn the Green

and the purple most of all

NOW to show y^t those Colours were not made by refraccon But were Originally in y^e Rays of the Sun. If you refract one of y^m never so much with Prism &c for Exaunple The purple in y^e first figure it will retain y^e same Colour

If you contract those refracted Rays with a Burning Glass they will all Converge to y^e Focus of all^{le} Rays as in y^e 2^d figure Where if you receive them on pap^r they will appear White And to show further y^t White is a Com= =posicon of all those collo^{rs}. If you inter= =cept y^e Blue Ray with a piec^e of paper betwixt y^e Focus & y^e Glass the white at the Focus will appear Roddish. If the Roddish be intercepted it will appear Bluish So y^t if one of these colo^{rs} be wan= =ting y^e White is imperfect

Fig: 3^d If you receive all y^e Rays on a piece of pap^r as at L fig 2^d betw the Focus of all^{le} Rays & y^e glass they will appear with y^r prop colours in y^t right order & converging towards

one another But if they be cast beyond the Focus, they'l appear in y^e proper Colours on the pap^r & to have diverged from one another Whence y^e order will be Inverted Viz the purple Ray will be in y^e place of y^e Red & y^e Red of the purple

To shew y^t the Rays wch differ in colour (tho they have y^e same Incidence) are differently refracted place a tall piece of wood with a hole in it fig 4 and a prism behind the hole at a convenient distance from y^e Window Then w^th it refract the several Rays one after another from y^e hole in y^e Darke room to y^e hole in the piece of wood & each of the Rays will be differently refracted on y^e opposite Wall Viz The Reddish will be least refracted & uppmost, The Orange next under neath, y^e Yellow next, y^e Green next the Blue next & y^e purple lowest of all

Those Obj^ts whose parts are so disposed as to reflect any one of these Rays more y^n y^e rest & in

a great measure to absorb & stifle
the others appear to be of that colour
wch they most reflect When a
Blow Ray when reflected on a blue
Obt appears much stronger then when
it is reflected on one of a different
colour & so of the rest If you look
thro a prism on an Obt of any one
perticular (R G) Green. You will see
in it all y^e other colours but y^e Green
being y^e most powerfull the Obt to y^e
sight of y^e naked Eye will appear alto=
=gether of that colour

Since White has been proved to
consist of all colours it follows from hence
that those Objts wch appear White to us are
such as are very copiously to reflect all
Colo^rs & y^e greater or less this disposicon
is in the Superficies of y^e Objt it will
appear accordingly of a quite White or
else of a some what Shaded or dark Brown
or some other intermediate colour &
those Objts wch are very little or not at all
disposed to reflect those Rays will appear
Black

It may be contrived by darkning
a room & by that means letting down
of Light fall very forcibly upon a Black

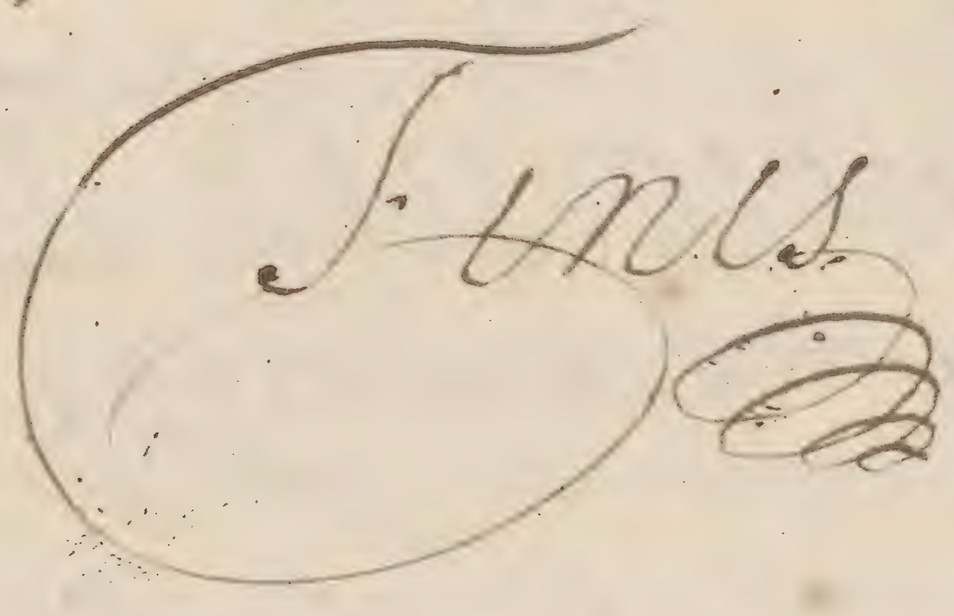
Obj^t that it shall then appear exactly
white to y^e Eye

If you expose 2 pieces of Marble
to y^e Sun One white the other black
The black will be hot & retain the
heat longer For as y^e white reflects
So y^e black absorbs y^e Rays of y^e Sun

If any Oblong piece of paper
plac'd before a window be viewed at a
distance thro a prism that y^e Light
from y^e window on y^e paper may make
an Angle equall to y^t wch is made
by it (i e) the Light reflected from the
paper to y^e Eye provided the paper
be terminated with Sides parallell
to y^e prism & y^e Horizon & distinguisht
by a perpendicular transvers Line
into two halves, the one of an intensly
Blew, the other intensly Red

If the refracted Angle of the prism
(i.e) its 2 sides — — thro wch the Light
passes to y^e Eye be turned upwds So y^t
paper may seem to be lifted upwds by
the Refraction Its Blue half will be
lifted higher by the Refraction than its
Red half But if it be turned downwds
So y^t y^e paper may seem to be carry'd

lower by the Refraction its Blue halfe
will be carryed something lower thereby
then its Red halfe Because in both
cases the Light wch comes from the
Blue halfe of the papr thro yr prisme to
the Eye is more refracted then that wch
comes from yr Red halfe



# A Description of the Condensing Engine with its Apparatus. pla 6

Fig 6 Is a Syringe or Syphon for injecting Air into the Still a a a a of Figure 10

Fig: 9 A Mercurial Gage made with a Glass Tube c c fixed into a piece of wood to know by the rising of y^e ♀ to w^ch degree the Air is condensed in y^e Still a a a a

Fig 7 b b b b Represent y^e brass Semisph^e g. a Cock to keep the injected Air from coming out. e e A hollow piece of Brass thro wch the Air is injected. d d A Brass plate to shut up y^e bottom of y^e Still a a a a

a. One of the brass Rings to hang the Weights to draw ye Hemisphs asunder

Fig:10 L the other brass Ring for ye above
mentioned purpose. a a a a Is a
Glass Vessell ariled with Brass hooks at C
the bottr to hoop in ye air condensed upon
ye hemisphs b b b b within the said Glass.
f a piece of Brass screwd to ye upper
Hemisphere to sustayn it by help of the
piece e e. g hanging upon ye hooke
L whilst in the Scale draw the lower
hemisphs from it without letting out the
condensed air. h h A Board with
two screwd pillars to fix the uppr
and Lower Brass plates to ye Brass
Vessell. d d The uppr brass plate
described in fig 8 with ye Collar of
Leathers ff that ye piece e e of fig
7 may slip up & down without letting
the Air

If the Air be exhausted out of the
Hemisphere (found only by a Wett
Leather) twill require above 130 pounds
to draw them asunder. If the Density
of the Air in ye Vessell a a a a be doubled
by the Quantities of injected Air on

the Outside of the Hemisphere
Tho the Air is not drawn out from
between them It will require as
much wright to draw them asunder
as before And double that Wright if
there is a Vacuum between the
Hemispheres Or if the Air is three
times as Dense as at first And if
the Air being 3 times as douse as at
first there be Vacuum between the
Hemispheres It will require 3 times
the Wright namely 390 to pull them
asunder

⊗ This refers to Page 57.

Cor: 1st How a Cylinder of Quick=
=silver of 27 or 28† inches gravitats as=
much as a Column of Air whose height
reaches to y^e top of y^e Atmosphere & whose
Basis is y^e same as that of the Column of
Quicksilver

† The Length of y^e Mercurial Cylinder varies according to y^e Height of y^e Air, which is different at different times — See Page 57. The different Height of y^e Mercury is from about 27½ to 30½ Inches

Experim

We may increase the Weight of the Air
by sinking the Barometer into another
Fluid, viz^t put it into a long Cylindric
Glass & afterwards pour Water on the Sur=
=face of y^e Stagn Mercury & y^e Mercury
will still rise higher in the Tube According
as the pressure of y^e Water increases About
14 Inches of water upon the Stagnt Quick=
=silver will raise that wch was in the
Tube about one Inch. Thro' being 14 to
one Between the Gravity of the Mercury &
y^e Water

# A Catalogue of the Experim^ts contained in this Book

# Mechanicks

## Lecture the first

An Experim^t to show What Cartesius meant by his Phisto Elem^ts

— Oil of Tartar pourd on Oil of Vitriol to caus^e heat

The Smell & Solidity of Campire destroyd & restord

— Cold produced by Sal Armoniac

Brass made to looke like Silver on the Sudden

Filings of Brass & Steel heatd by Aqua-fortis

The colour of Ink destroyd by Aqua-fortis

— Phosphorus

The phaenomena of the Eolipile

# Lecture the 2d

4 Experim concerning Mocon & Ve Locity

An Experim to show ye Effect of Mechanicall Engins in gerall

Three Expim concerning the Centry of Gravity, Magnitude & Mocon

1 a Rolling Lamp

to a Mechanic Way of finding the Centr of Gravity of a Body

4 An Expim concerning the Comon Centr of Gravity of two Bodys

An Expim concerning the Centr of Gravity of a Ballance

1

# Lecture the 3d

L An Expim concerning the Line of Direccon of a power & that of a Weight

L An Expim concerning the distance of a powr or Weight

4 Expirim to illustrate the Suppositions

A heavy Body made to roll upwards by its owne Gravity

A heavy Body wch of itself would fall from a Table, hindred from falling by adding a heavyer Body to it

— Another Way of making the Experiment

Experiments about the falling, rolling & sliding of Heavy Bodies

## Lecture 4th

Eight Experiments concerning the Balance

Four Experiments concerning the several kinds of Levers

Three more Experiments concerning the Lever

— Upper & Lower pullys reduced to Lever

— Three Experiments concerning Pullys

Two Experiments concerning the Axle in the Wheel

— Three Experiments concerning the Wedge

— Two Experiments concerning the Screw

— A Compound Engine

## Lecture the 5th

— The first Law of Nature proved by Experiments

Experiments concerning the Centripetall and Centrifugall force of a Solid or Fluid in Vacuo

A heavy Body made to rise &
a Lighter to descend by means of Centri=
=fugall force given to y^e heavy Body

Expm^t to shew What motion a Body
will have when its Centrifug^l force is
equall to, greater or less than its force of
Gravity

Oyle made to descend in Water
Oil made to descend in Water

## Lecture the 6th

This Second Law of Nature proved by Expm^ts

4 4-4 4 4 4-4 4-4 4 4

Four Expr^ts concerning Bodys on
incline Plains.

- Three Expm^ts concerning pendula

## Lecture y^e 7th

The third Law of Nature proved by Expm^ts

The Phaenomena of the Loadstone

- An Expm^t to shew y^e reason of y^e Tide
- Several Electricall Expm^ts
- An Explanation of the Motion of the
planets round the Sun

## Lecture 8th

Expm^t concerning the Congress of
hoavy Bodys

— Lowdall Expm^t to illustrate Elasticity

Expm^t concerning a Lachryma
or Glass-drop

Nine Expm^ts concerning the Congress
of Elastic Bodys

# Hydrostaticks & Pneumatick

## Lecture the 9th

An Expm^t to show that the Uppr
parts of Fluids press upon the Lowr

— That Water weighs in Water

Three Expm^ts to shew that the pressure
of a Fluid upon y^e Bottom of a Vessel w^ch
contains it is according to y^e height of
the Side of the Vessell Be the top wide or narrow

Expm^t to shew that Fluids press upw^ds,
downwards & Sideways according to their
height

An Expt to show Whr a Barrel tapt in any determinate place will Spout

Expts to show Why & How high Water will rise in Fountains

& Three Expts to make Lead swim in Water

## Lecture the 10th

Several Expts to show how the Specifick Gravity of Bodies may be found Whether they sink or swim in Water

An Expt to show Whether a piece of Gold be good or bad by weighing it in Water

— Water Clocks

An Instrum to find the Specifick gravitys of all Liquors

— Suction & Syphons explaind

— The nature and pressure of the Aer

Bubbles of Glass or little Images made to rise & fall in Water

Several more Expts on Glass Bubbles

Lecture the 11th

The preasure of air upon Fluids and Solids

— Shows diffocult sorts of Fountains

— The Divers Bell

— Artificiall Lungs

— The manner of Cupping

— Sucking, Lifting, & forcing Pumps

Lecture the 12th

Shows all sorts of Weather-glasses Viz Barometers, Thermometers and Hydrometers

Lecture the 13th & 14th

Fifty or more Experiments upon the Air-pump

Lecture the 15th

— Expiment made in a Condensing Engine

The Expiment to show That as great a weight is requir'd to draw two Brass Hemisphers asunder When the Density of the Air ou—

the outside of ẽm is doubled (tho y^e Air
betwẽ ẽm be of y^e same nature with
the comon Air) as when there is a
Vacuum made betwẽ ẽm

Another Experim^t shewing That if
the Air in y^e Vessell conteyning the
Sphere be made three times more
Dense, then y^e Air betwẽ ẽm, they
will require twice as much weight to
draw ẽm asunder

A Bottle broken by condensing the
air on y^e Outside of it

SOUND increased by condensing
the air

— phosphorus put out by condensing Air

— Four or five more Expim^ts in y^e Engine

# Opticks

## Lecture the 16th

Four Experim^ts to shew the Nature
and Mocon of Rays of Light

— An Expim^t to shew Vision in gen^rall

— Four Expim^ts on plain Mirrors

— Three Expim^ts on Concave Mirrors

— Three Expm^ts on Convex Mirro^rs
— A Cylindrick Concave Mirrour

## Lecture the 17^th

Six Expm^ts to show the manner of Refraction

— A Multiplying Glass
— Six Expm^ts on Convex Glasses
— The Darke Chamber
— The Magick Lanthorn

## Lecture the 18^th

Six Expm^ts to show by the help of Threads how Rays pass thro Concave & Convex Glasses

An Experiment upon a piece of Money which in a Glass of Water appears bigger &c and this

— The Dissection of the Eye

An Instrument to show the manner of Vision

— The portable Camera Obscura

The faults of Vision shewd by an Instrument

Two Expm^ts to show how the Myopis or

prisbyse may be holp'd

## Lecture the 19th

Six Expmt^s on a Concave Lens

Six Expim^ts to shew How to find the Focus of a Lens & whether it be truly contr'd

— A Meniscus Glass

— An Aeriall Speculum —

An Expmt to shew the difference between Seeing & Seeing

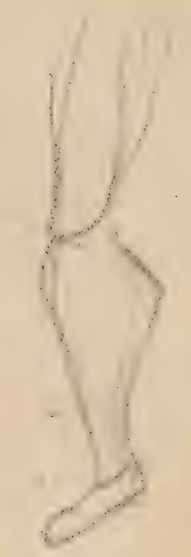
An Expmt to shew How Beams serve to dart from a Candle

An Expmt to make two Candles seem Eleven.

An Expmt to shew Why both Eyes — see things only single

## Lecture 20th

Of all kinds of Microscopes and Telescopes

## Lecture 21st

Of Sr Isaac Newtons Theory of Light & Colours proved by Expm^ts